Developing and testing methods to engage communities in air quality issues an air pollution case study in London

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DEVELOPING AND TESTING METHODS TO ENGAGE COMMUNITIES IN AIR QUALITY ISSUES

AN AIR POLLUTION CASE STUDY IN LONDON

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Abstract

Exposure to air pollution is a public health concern accountable for numerous health problems and tens of thousands of premature deaths each year in the UK. Despite this evidence, public understanding and awareness of the issue is low in comparison to other public health risks. Improved methods for engaging with the public to communicate this risk are required. Participatory research methods have been used in the air pollution field predominantly in unpublished work. However, there is still a lack of systematic empirical evidence on the feasibility of using this approach with diverse members of the community and on the impact that this approach can have on people's views and perceptions of air pollution.

Bringing together natural and social science techniques, this interdisciplinary PhD research aims to investigate the feasibility and impact of using participatory research interventions which involve the collection of personalised exposure data, with community groups to raise awareness of air pollution and identify potential solutions.

Over 500 individuals, belonging to five community groups in London - including a primary school, a senior citizens group, a Chronic Obstructive Pulmonary Disease (COPD) patient group, and a parent and baby group – were recruited to take part in participatory research projects. The projects began with the provision of information on air pollution causes and effects. Subsequently, using portable exposure monitors and GPS watches, a subset of individuals from each group measured their own exposure to air pollution in the course of their normal activities. Each participant received a summary of their own findings and the overall results of the project were shared with all members of the community groups. Participants also included a group of activists and politicians who had taken part in similar projects, but on their own accord. Data on the impact of the participation in the projects were collected using observations, surveys and interviews.

The study found that participatory methods can be implemented in practice and have the potential to be effective and engaging tools for raising awareness of air pollution as a health risk amongst communities by supplementing information provision with active collection of personalised exposure data. Drawing on theoretical notions of risk, the study found that participants' perceptions of risk were culturally dependant and, therefore, conceptualised in

different forms. This study showed that while air pollution is a modern complex risk, it doesn't have to be confined to the realms of scientific experts and that, on contrary, lay people through the gathering of own exposure data can help unveil and address the risk. The findings from this study suggest that by taking an active role in the research process, individuals are inspired to not only reduce their own air pollution exposure but also think about ways in which they could reduce their own contribution to the problem as well as how they could influence other people's practices in order to reduce their exposure and contributions.

The findings from this study have the potential to provide policy makers with new engagement and communication methods for delivering more efficient and effective public health interventions.

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Finally, and most importantly, I thank God for showing me the way and giving me the strength to follow it.

Abbreviations

Abbreviation	Meaning
ARCaRe	Adult Respiratory Care and Rehabilitation
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
BC	Black Carbon
BLP	Breathe London Project
CAZ	Clean Air Zone
CCS	Congestion Charge Zone
COMEAP	Committee on the Medical Effects of Air Pollution
COPDG	Cardio Obstructive Pulmonary Disease Group
DEFRA	Department for the Environment, Food and Rural Affairs
ERG	Environmental Research Group
ESRC	Economic and Social Research Council
GLA	Greater London Authority
GPS	Geographical Information Systems
IDR	Interdisciplinary Research
LA	Local Authority
LAQM	Local Air Quality Management
LEZ	Low Emission Zone
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides collectively
PAR	Participatory Action Research
PR	Participatory Research
PRA	Participatory Rural Appraisal
P&BG	Parent and baby group
PM_{10}	Particulate matter (diameter less than 10 microns)
$PM_{2.5}$	Particulate matter (diameter less than 2.5 microns)
PS	Primary School
SCG	Senior citizen group
SO_2	Sulphur dioxide
U3A	University of The Third Age
ULEZ	Ultra-Low Emission Zone
WHO	World Health Organisation

Chapter 1 - Introduction

1.1 Motivations for the thesis

Following the completion of my MSc in environmental technology, I started a job as air quality consultant, working on projects involving monitoring and modelling of air quality. As part of this job, I also had to provide assistance to Local Authorities in managing air pollution in their area through the Department for Environment, Food and Rural Affairs (Defra) support program - Local Air Quality Management (LAQM). Through my educational background and my position as an air quality consultant, I was able to recognise the sources and magnitude of the air pollution problem in our city, as well as the effects of air pollution on human health. However, I always wondered how lay people could understand and recognise the importance of tackling the air pollution problem if they could not see it. The opening sentence of my personal statement when applying for my PhD studentship 5 years ago was - *Air pollution, the invisible killer, needs to be unmasked! How can we do it?* Finding the answer to this question is what prompted me to embark on this doctoral research.

From the inception of this PhD research, it was clear that in order to address the research question, I would need to embrace an interdisciplinarity approach to research, integrating natural science (exposure science) and social science (public health). Public health is considered to be an applied social science discipline (Badgley, R. F., et al, 1963). It has been argued that interdisciplinarity has an important role to play in order to address the challenges faced by modern society (Cuevas et al.,2012). This is something that has also been recognised by funders who play an increasingly important role in encouraging interdisciplinary research (Global Research Council, 2016, British Academy, 2016). It is expected that the use of interdisciplinarity in this research will provide a better understanding on how people are exposed to air pollution and where the risks are the highest, while also providing understandings around how people conceptualise and perceive air pollution as a risk.

The Economic and Social Research Council (ESRC) funded my three year studentship plus an additional three months of qualitative methods training, so I could learn social science techniques and apply them to issues arising in my own discipline (air quality science). In the context of air pollution, interdisciplinary research methodologies are essential in order to ensure that complex risks are accurately assessed, and subsequently communicated to lay members of the public in an effective and engaging way. As the development of technological

solutions to improve environmental quality have become more challenging, understanding public attitudes and the acceptability of policy choices will become more important. Policy makers, therefore, require tools to assess relative levels of acceptability in order to put in place suitable and effective policies. Therefore, throughout this thesis, interdisciplinarity has been used as a means to an end and not as an end in itself.

1.2 Why this thesis and why now

Air pollution has been associated with a wide variety of health problems including heart disease and stroke (Shah et al., 2015), the exacerbation of pre-existing respiratory conditions, and cognitive development issues in children (COMEAP, 2010, Atkinson et al., 2015, Gowers et al., 2014). The Global Burden of Disease Enterprise estimates that more than 5.5 million people die prematurely each year due to air pollution (Global Burden of Disease et al., 2015). Furthermore, air pollution is one of the leading threats to child health, accounting for almost 1 in 10 deaths in children under five years of age (World Health Organisation, 2018). Recent research estimated that the total mortality burden of air pollution in London for the year 2010 was up to 140,000 life-years lost, which is equivalent to 9,416 premature deaths at typical ages (Walton, 2015).

The problem of air pollution is particularly significant in large urban settings due largely to the high number of vehicles on the roads. The visible air pollution in Indian and Chinese cities tend to attract more headlines, however, meeting legal limits is also a challenge faced by major cities across Europe. While the air pollution that we breathe in London is characteristically difficult to perceive by the naked eye, London has been at illegal levels since 2010. The law requires that the hourly measurement of toxic nitrogen dioxide (NO_2) must not exceed 200 micrograms per cubic metre (μg/m3) more than 18 times in a year. However, limits for the whole year have been reached within a month, year after year, in many parts across London (London Air, 2018).

In London, several measures have already been introduced in order to tackle air pollution (Greater London Authority, 2010, Greater London Authority, 2013), such as encouraging active travel (e.g cycling), reducing emissions from transport through the promotion of technological change (e.g. by retrofitting buses with a new exhaust system that reduces their emissions), and restricting polluting vehicles from entering central London through the implementation of the London Low Emission Zone (LEZ) (Greater London Authority, 2010). In order to improve air quality in London, the Mayor has also introduced taxes to discourage drivers from entering the inner city such as the congestion charge zone (CCZ) and the Emission Surcharge (T-Charge). Despite these measures, the levels of air pollution in several areas of London remain high and above legal limits (Defra, 2015).

Studies have shown that reducing exposure to ambient fine particulate matter can contribute to significant health improvements (Brook et al., 2010, Laden et al., 2006). Furthermore, there are several choices that individuals can make in order to immediately reduce their exposure to air pollution and therefore, reduce the risk of an adverse impact on their health (Holgate et al., 2016). Such choices include, opting for a running or walking route that avoids traffic and when driving along busy roads, closing windows while setting the car's ventilation system to "recirculate", amongst others (Laumbach et al., 2015). However, although the impacts of air pollution on public health have been compared to those of obesity and smoking, not enough has been done to clearly communicate the risks of air pollution to the public (Environmental Audit Committee, 2014), public and political awareness of the problem remains low. This is partly a reflection of undeveloped methods for information dissemination and public engagement, which have been mostly limited to information dissemination approaches, assuming that the public would change its practices once been made aware of the problem. This approach known as the 'information deficit model' assumes that educating people about environmental issues will automatically lead to more pro-active environmental behaviours (Burgers 1988). Therefore, it is of particular importance to not only identify engaging and effective ways to raise air pollution awareness among the general public (Environmental Audit Committee, 2014), but that we also find ways to stimulate changes in practices. People need to be aware of how air pollution can affect their health and they also need advice and information on how to limit their exposure to harmful pollutants. However, unlike the thick smogs of the 1950s, air pollution today is largely invisible and hence less noticeable to those affected. What effects would enabling people to "see" air pollution have? Would people be more aware of the dangers posed by air pollution and try to avoid it, and or reduce their own contribution to the problem?

Air pollution monitoring is normally carried out by experts using expensive, complex stationary equipment. However, advances in wearable air pollution sensor technology are changing the air pollution monitoring paradigm (Snyder et al., 2013), making air pollution monitoring possible and accessible to the general public. Furthermore, low-cost, easy-to-use air pollution sensors to track personal exposure to air pollution (similar to those worn by individuals to track physical activity), can be used to raise individuals' awareness of exposure to air pollution. Many studies have used portable air pollution monitors and Global Positioning System (GPS) tracking devices to measure individuals personal exposure to a range of pollutants (Buonanno et al., 2013, Nieuwenhuijsen et al., 2015, Jeong and Park, 2017, Williams and Knibbs, 2016). Most of these studies documented the different activities and places where individuals were most likely to be exposed to high levels of black carbon (BC), as well as the degree to which their exposure to air pollution varies during the day. Some of

these studies have pointed to the potential value of using wearable technology to provide insights into personal exposure to air pollution (Nieuwenhuijsen et al.,2015) and to raise awareness of air pollution (Snyder et al., 2013, Jerrett et al., 2017).

Participatory research methods have been used extensively in the air pollution field as a tool for engaging with people, creating projects aimed at achieving social objectives. Furthermore, it has been argued that by connecting research and action at community level, participatory research has the potential to combine science, practice and policy to address health inequalities (Minkler, 2010). Participation in air pollution monitoring using low-tech equipment has not only been used to measure participants' exposure to air pollution. It has also been used to engage people in the research design and development of prototype mobile devices (Rohlman, 2015) and also as a way for citizens to express their concerns and care about the environment and health of their communities (Gabrys, 2017, Kondo, 2014). The potential of using low-cost air pollution sensing devices and web based tools to gather information about changes in individuals' perceptions of air quality as a consequence of taking part in such interventions have also been documented (Sîrbu et al., 2015, Commodore et al., 2017). However, little is known about the impact of participation in such interventions on participants' perceptions of and responses to air quality. There is also limited evidence on participants' motivations for taking part and on how they respond to the data collected. Likewise, the extent to which individuals disseminate the information they gathered with other members of their community is poorly documented.

It is expected that the findings from this study will provide empirical evidence on the acceptability, engagement and impact that participatory research methodologies which involve the collection of personalised air pollution data can have on the general public.

This PhD study aims to contribute to understandings of awareness and perception of air quality in relation to air quality monitoring. For this purpose, I worked with a number of community groups in London: primary school (PS), parent and baby group (P&BG),senior citizen group (SSG) and a Chronic Obstructive Pulmonary Disease patient group (COPDG) helping them to design, implement and interpret their own air quality monitoring projects around schools and neighbourhoods. I gathered qualitative data on the experiences of participants that took part in community-based air pollution monitoring projects using wearable technology, as part of the 'Breathe London Project' founded in 2014 by the Biomedical Research Centre at Guys & St Thomas NHS Foundation Trust & King's College London.

I, therefore, framed my PhD around the following question:

> *Can community-based participatory research interventions, which involve the collection of personalised data, be used to aid the development of effective methods of engagement with community groups to improve the local environment and public health?*

In order to address my research questions in a more step by step manner, I developed the following sub-questions which are addressed in my three result chapters.

1. *What motivates people to take part in participatory research which involves the collection of personalised data? And, what are the views and perceptions of those who take part in regard to their own project outcomes, expectations, interpretation of the data and further use of the findings?*

2. *How do people perceive and understand the risks posed by air pollution? And, how can the perceived risks be communicated using a participatory approach to research?*

3. *How do people who take part in participatory air pollution research, using personal air pollution monitors, perceive air quality policy and can this impact on policies to tackle air pollution?*

1.3 The challenges of interdisciplinary research

While, it has been recognised that interdisciplinary research (IDR) is needed for addressing complex, often multi-dimensional challenges and achieving societal impact (Global Research Council, 2016, British Academy, 2016), those who decide to embark on interdisciplinarity endeavours can be faced with a number of challenges.

Interdisciplinary research, often requires additional time and effort to carry out investigations having an impact on deliverables, deadlines and available resources. Furthermore, the lack of effective ways to evaluate the performance of interdisciplinarity approaches has also been identified as one of the difficulties when conducting IDR (Global Research Council, 2016).

There are also challenges associated with the reviewing process, as it may be difficult to find reviewers with the right expertise across a number a disciplines, and aligning insights from different academic backgrounds can be a hurdle (Global Research Council, 2016). It has also been argued that maintaining the interdisciplinary researcher's identity, expertise and position in their university can be challenging (Lyall, et al., 2011). The latter can be particularly so for

early career researchers who are beginning to learn the scientific discourses associated with their discipline (Salter and Hearn, 1996).

Despite these challenges, I endeavoured to adopt an IDR approach in this PhD in order to address my research question, which I believe could not have been adequately addressed through a mono-discipline lens.

1.4 The structure of the thesis

In Chapter 2, I provide the context and set the stage for this thesis. I provide a brief historical background on air pollution and I outline the air quality legislation framework in the UK, as well as the modern-day sources of air pollution and the associated health impacts. I present and discuss how air pollution is measured using conventional static monitoring and emerging portable air pollution monitors. I discuss the UK government's efforts to engage with the public and I explore the literature on public perceptions of air pollution.

In Chapter 3, I discuss the methodologies used in this study, ethnography and participatory research. In the first part of this chapter, I reflect and present my ontological and epistemological positions and the rationale for using an ethnographic approach for this study. In the second half I explore the concept of participatory research, including the extent to which it has been used in the air pollution field.

In Chapter 4, I explain the different methods I employed for data collection and analysis. In this chapter, I also provide detailed information about how the air pollution community-based projects developed for each of the four community groups.

In Chapter 5, I provide an overview of each of the four community groups that took part in these studies, as well as information about participants. I also provide information about the participants I interviewed from the 'Breathe London Project'. An overview of the heightened media interest in air quality during the period of fieldwork is also presented.

In Chapter 6, I explore participants' motives and implications of taking part in participatory research projects which involve the collection of personalised data. I present the views and perceptions of those who take part in the process in regard to their own project outcomes, expectations, interpretation of the data and further use of the findings.

In Chapter 7, I present how people understand the risks posed by air pollution. In light of Beck's (1982) theory of risk society, I explore how sociological notions of risk offer important insights into how to communicate air pollution as a health risk.

In Chapter 8, I explore how people who take part in participatory research approaches perceive air quality policy and I discuss how can these views and perceptions impact the effectiveness of policies that aim at tackling the issue.

The concluding chapter offers a summary of the findings and outlines my contributions to the fields of participatory research, risk communication and science communication. I reflect on use of a participatory approach in my role as a graduate-student and I also reflect on the lessons learned from using this approach. I consider the strengths and limitations of this PhD and I suggest avenues for future work. Finally, I point to this thesis' broader implications for science policy and public health.

Chapter 2 - Air quality context

Introduction

Air pollution is a local, regional and international problem caused by the emissions of pollutants which have negative impacts on human health and the environment. The purpose of this chapter is to provide the context and set the stage for the research question "how can access to relevant personalised environmental information (air quality data) gathered through community led-projects be used to aid the development of effective methods of long-term engagement with community groups to improve the local environment and public health?".

This chapter begins with a brief historical background on air pollution and the air quality legislation framework in the UK. The modern-day sources of air pollution and the current evidence on the health impacts of air pollution are presented. I discuss the legal and policy frameworks in the UK to address air quality and how air pollution is measured, highlighting the conventional and emerging air pollution monitoring technologies. I conclude this chapter by discussing the UK government's efforts to engage with the public and exploring existing literature on public's perception of air pollution.

2.1 Historical context

The rapid population growth, urbanisation and the increased use of coal as a fuel source for industry and domestic activities were the main causes of air pollution until the 1950s, with smoke and sulphur dioxide (SO_2) being the main pollutants (Brimblecombe, 2006). The London smog of 1952 in London is regarded as the worst air pollution event ever recorded in the UK. During this episode, a combination of high emission rates mainly from the domestic and industrial burning of coal and unprecedented weather events resulted in a toxic mix of dense fog and smog which poisoned the air and caused approximately 4000 deaths (Wilkins, 1954). This episode led to the Clean Air Act of 1956, which provided for the establishment of smokeless zones on a national scale and provided subsidies to households to convert to cleaner fuels. The focus of this policy was purely on smoke from coal, and SO_2 emissions were not directly regulated, although subsequently, SO_2 emissions also decreased together with smoke levels. The Clean Air Act of 1956 was extended in 1968 where the idea of using tall chimneys for industries burning coal, liquid or gaseous fuels was introduced. At that point, it was thought that the smoke pollution could be controlled, but that sulphur dioxide removal was difficult. Therefore, attempts to reduce sulphur dioxide focused on releasing the pollutant emissions as

high as possible to obtain better dispersion. Together these pieces of legislation are partly responsible for 50 years of air quality improvements in the UK and set an important example of environmental legislation around the world (Brimblecombe, 2006).

2.2 Air quality legislation context

While the legislative approach adopted by the early clean air acts focused on the sources of emissions, UK legislation today follows a different approach. Nowadays, legislation has standards of the quality of air (based on health effects) and targets for each specific pollutant with achievement dates specified.

The most important recent piece of legislation in the UK relating to air quality is part IV Environmental Act 1995, which requires the UK government and devolved administrations for Scotland and Wales to produce an Air Quality Strategy (AQS) containing standards, objectives and measures for improving ambient air quality (GOV.UK, 1995). The first National AQS was published in 1997 and was updated as "The Air Quality Strategy for England, Scotland, Wales and Northern Ireland" in January 2000. The Strategy includes health-based targets for eight air pollutants: benzene, 1,3-butadiene, CO, lead, NO_2, ozone, PM_{10}, and SO_2, to be achieved between 2003 and 2008. The Air Quality Strategy latest version was published in 2007 (Defra, 2007). The AQS provides a framework for local air quality management. Under this legislation, Local Authorities (LAs) in the UK have a legal responsibility to review the air quality in their area and assess whether air quality objectives (Defra, 2016) will be achieved. Local authorities are required to declare an Air Quality Management Area (AQMA) if they identify that the air quality objectives are not likely to be achieved. Subsequently, LAs must develop an Air Quality Action Plan which should set the required improvements needed to improve air quality in the affected area.

In an effort to manage and improve the air quality, the European Union (EU) introduced The 2008 EU Ambient Air Quality Directive, which sets legally binding limits for major pollutants such as particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO_2) (Defra, 2017). This directive was transposed into UK law, by the Air Quality Standards Regulations 2010. Under this Directive, all member states are required to carry out air quality monitoring and assessment, report on the results of this monitoring, and plan and implement measures to meet the objectives. In the UK, the government is responsible for meeting the EU air quality objectives across the country. In London the mayor is responsible for meeting them for the city. The Mayor has the legal responsibility to prepare and AQS for delivering improvements to air quality. The 2010 AQS (Greater London Authority, 2010) produced by Boris Johnson (Mayor of London, 2008–16) was replaced by a new "London Environmental Strategy" in

2018, which brings together approaches to every aspect of London's environment (including air quality).

Early in 2019, the UK government released the Clean Air Strategy 2019 which aims at reducing harmful pollution, including a range of actions to tackle the problem (e.g. air pollution messaging service to provide advice and information to help those most vulnerable to air pollution) (Defra, 2019). This piece of legislation has been criticised for its lack of detail on how some of the proposed measures would be enacted (Y Tang, 2019).

2.3 Sources and types of modern-day air pollution

Modern air pollution may not be so visible like the smoke, grit and dust of the 1950's, but, arguably, the air pollution problem, particularly in major cities, remains a matter of great concern. Sources of air pollution have changed considerably since the 1950s, with smoke and sulphur dioxide (SO_2) now regulated and under control, coal combustion is no longer the main cause of air pollution. Nowadays, road transport is the main source of air pollution, and its contribution to the overall pollution is on the increase. More than 50 per cent of the current world population is currently living in urban areas (World Health Organization, 2014) in close proximity to traffic emissions. Fossil fuel power generation, domestic combustion and agriculture also contribute to the air pollution problem. The current air quality problem in the UK is caused by three key pollutants on which the UK is failing to meet national and European targets: nitrogen dioxide (NO_2), particulate matter (PM) and ozone (O_3) (Holgate et al., 2016).

Nitrogen dioxide (NO_2) is one of a group of gases called nitrogen oxides (NO_x) and it is emitted from combustion processes (heating, power generation and engines in vehicles and ships). Road transport accounted for 32 per cent of UK NO_x emissions in 2017 (Defra, 2019). Therefore, nitrogen dioxide levels are highest near busy roads and in large urban areas, with peaks coinciding with rush hour traffic. Nitrogen dioxide is a pollutant of particular concern as its levels have not fallen as quickly as predicted (Carslaw et al., 2016). This appears to be the result of an increase in the use of diesel cars which create more nitrogen dioxide than was anticipated (Carslaw et al., 2011). The rise of diesel vehicles started back in the 90s when, in a bid to reduce CO2 emissions as agreed in the Kyoto protocol climate change agreement, Europe backed a major switch from petrol to diesel cars. Diesel engines are known for having better fuel economy, so the switched was supposed to reduce carbon dioxide emissions. The UK, along with other European countries, offered incentives to encourage the public to buy diesel cars and now over 50% of cars in the UK run on diesel. While switching to diesel cars to minimise climate change may have seemed like a sensible idea, diesel cars have some drawbacks. Diesel cars can emit higher levels of other harmful pollutants such as nitrogen dioxide, which have direct effects on human health. Moreover, in September 2015, it was

found that many diesel cars were not meeting legal emissions limits under real driving conditions. Automakers have flouted emissions limits by using a 'defeat device' which was able to sense when the car was being tested and switched the engine to run in a low-emission mode, but once on the road the emissions were well above the limits (Brand, 2016). This unlawful behaviour was known as the 'dieselgate' emission scandal. The performance gap between test and real driving emissions can partially explain why NOx emissions continue to be above legal limits in many European countries. (Beevers et al., 2012). Since 2010, the UK has been failing to meet the standards of the Air Quality Directive (Defra, 2015).

Particulate matter (PM) are tiny particles from a variety of sources, including natural (volcanic emissions, sea spray, resuspension of mineral dust) and anthropogenic (vehicle and industrial combustion, agriculture, abrasion). Particulate matter is often categorised by particle size, most common categorised as smaller than 10 microns in diameter (PM_{10}) or smaller than 2.5 microns ($PM_{2.5}$). Particles originating from road traffic include carbon emissions from combustion in engines, as well metal, rubber and other compounds from engine, tyre and break wear, and dust from abrasion of road surfaces (World Health Organization, 2013). It was estimated that emissions from road transport accounted for 12 per cent of PM_{10} and $PM_{2.5}$ in 2016 (Department for Environment Food and Rural Affairs, 2018). Other sources of particles include materials from construction and demolition as well as wind-blown dust, sea salt, pollen and soil particles (Adams et al., 2015).

Ozone is a pollutant in the lower atmosphere. It is principally not emitted directly from any man-made source but is formed by the reaction of sunlight with pollutants such as nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOCs). As this formation reaction is driven by sunlight, ozone concentrations are usually greatest during hot sunny days and they can accumulate and travel long distances away from the original source of precursor compounds.

In the following section, I outline the various adverse health effects that have been associated with short and long term exposure to air pollution.

2.4 Air pollution health impacts

It has been suggested that each year in the UK, around 40,000 deaths are attributed to exposure to outdoor air pollution linked to exposure to fine particles and NO_2 (Holgate et al., 2016). Air pollution has been associated with a wide variety of health problems including heart disease and stroke (Shah et al., 2015), increases in diastolic blood pressure and reduce lung function, in healthy adults (Cole-Hunter et al., 2018), exacerbation of pre-existing respiratory

conditions, and cognitive development issues in children (COMEAP, 2010, Atkinson et al., 2015, Miller BG and Hurley JF, 2006, Liu and Lewis, 2014). Furthermore, it has been suggested that the damage caused by air pollution occurs across the life time, from a baby's first weeks in the womb all the way to the years of older age (Holgate et al., 2016). Children are particularly vulnerable to the harmful effects of air pollution, due to their immature and developing immune system and lungs, lower body weight and relatively high inhalation rate (Gehring et al., 2013, Kim, 2004, Holgate et al., 2016, Suglia et al., 2008) (World Health Organization, 2005a). Individuals with pre-existing cardiovascular and respiratory diseases as well as older people are also particularly at risk.

Although air pollution is potentially harmful to everyone, it has been suggested that individuals who live in low-income areas tend to be particularly affected, due to a number of factors such as the lack of green spaces, living near busy roads, poor diet and underlying health issues (Defra, 2006, Wheeler and Ben-Shlomo, 2005, Fecht et al., 2015).
Air pollution can cause short term (nearly immediate symptoms) and long term (chronic disease) effects (Holgate et al., 2016). Short term health effects normally occur when weather conditions cause pollutants levels to increase above normal background conditions causing 'air pollution episodes' which can last several days. Those with existing breathing problems can be severely affected. Long-term health effects happen at lower air pollution levels than the short-term effects and are often not noticed by people until the damage is already done.

Exposure to NO_2 can cause irritation and inflammation of lungs, which can reduce immunity to lung infections such as bronchitis. Exposure to NO_2 has also been associated with reduce lung function at concentrations currently measured in cities of Europe and North America (WHO, 2016). Studies have suggested that the health effects of NO_2 exposure are more pronounced in children and in people with asthma compared to healthy individuals (Lewis et al., 2013)

Larger particles are normally filtered in the nose and throat and are not of great concern. However, particles smaller than about 10 micrometers, (PM_{10}) and particles smaller than 2.5 micrometres ($PM_{2.5}$), can be inhaled and penetrate the deepest parts of the lungs, and some can even enter the blood stream and be transported to other organs causing adverse effects on health (Nieuwenhuijsen, 2015). Exposure to particulate matter has been linked to a range of adverse health effects including cardiovascular disease (Brook et al., 2010), impaired lung function, lung cancer and exacerbating existing illnesses, such as asthma (Atkinson et al., 2015, World Health Organization, 2012a, World Health Organization, 2013). Scientific studies have also linked particle pollution exposure to a variety of problems, including:

reduced fetal growth (Stieb et al., 2012, Smith et al., 2017), increased risk of dementia and Alzheimer‘s disease (Weuve, 2014, Oudin et al., 2016). The latest report produced by the Health Protection Agency for the Committee on the Medical Effects of Air Pollutants (COMEAP) concluded that “anthropogenic $PM_{2.5}$ at 2008 levels had an effect on mortality equivalent to nearly 29,000 deaths in 2008 in the UK”. This report also stated that the loss of life-expectancy due to $PM_{2.5}$ at 2008 levels was estimated at about 6 months (COMEAP, 2010). Low level ozone also has negative impacts in human health. At higher levels, ozone can irritate and inflame the lungs, causing breathing problems, triggering asthma and reducing lung function. In sensitive individuals such as asthmatics, ozone pollution episodes can make breathing difficulties worse (World Health Organisation, 2016).

2.5 The legal battle for clean air

Meeting legal air pollution limits is a challenge faced by many major cities across Europe. The UK failed to meet limit values for NO_2 by the January 2010 deadline set by the European Union Directive 2008/50/EC in a number of areas and this has led to the UK government facing a series of court cases brought by the environmental law firm ClientEarth. The long running legal battle started in 2010 when ClientEarth took the UK government to court for failing to comply with nitrogen dioxide legal limits, with ClientEarth winning rulings in both high court and supreme court in 2013. The court ordered the government to draw up, by the end of 2015, an air quality plan to comply with Air Quality Standards.

In 2016, the environmental law firm took the UK government once again to court as they considered the air quality plans proposed by the government inadequate. Once again, the courts ruled in favour of ClientEarth and ordered the government to publish by 2017 a new strategy which set up plans for cutting air pollution levels as soon as possible. Early in 2017, the government made an application to be granted an extension for publishing the revised strategy after the general elections. The request was denied by the judge and the government was forced to comply with the initial deadline and publish the new draft plans. These draft plans were subject to a public consultation with the actual plans published in July 2017. The main highlight from the long-awaited document include a requirement for local authorities to solve the issue, principally via the creation of Clean Air Zones (CAZs). One of the tangible successes of the ClientEarth litigation work was the increase in the number of cities which required CAZs, that went from six in the 2015 plan to 27 in the 2017 plan. Despite this, the 2017 plan was heavily criticised for putting the onus on Local Authorities, which ability to deliver effective plans to tackle air pollution may be restricted by local budgets.

Early in 2018, Client Earth won a third case against the UK government, this time for the government's failure to require action from Local authorities with illegal levels of air pollution. The high court ruled that the government's policy on air pollution was "unlawful", and ordered changes (ClientEarth, 2019). Although the government's plans are ambitious in the long term, they lack short-time action. Therefore, for now and until any of these plans are put into practice and yield any positive results, air pollution will remain a public health problem.

2.6 Exposure to air pollution

When considering air pollution and how to control its detrimental effects on human health, it is important to understand the processes through which harmful pollutants can enter our bodies and how we can reduce and/or mitigate the risk of exposure. For this purpose, it is useful to examine the source (where, what and how much pollutants are being emitted), the pathway (how can this pollutants travel through the environment) and the receptor, (who and what can be affected) (Nieuwenhuijsen, 2015). Following emissions, air pollutants are transported through dispersion processes leading to ambient concentrations. These can be in particular places, creating 'micro-environments' such as houses, travel routes, modes of transport and work places where people are exposed to their harmful effects (Nieuwenhuijsen, 2015). Therefore, exposure to air pollutants can vary throughout the day according to the different micro-environments encountered by and individual.

As mentioned in Section 1.3, the current main source of air pollution is road transport, particularly in urban settings (World Health Organization, 2005b). As a result, individuals who live near busy roads tend to be more affected, as well as individuals who commute along busy roads, where short but high episodes of air pollution exposure can occur (Int Panis et al., 2010). Similarly, the modes of transport individuals choose for traveling can also have a direct impact on their air pollution exposure. For example, recent studies have suggested that individuals who travel by car are exposed to relatively higher PM concentrations on average compared to other transport methods (Karanasiou et al., 2014) such as cycling and walking (Adams et al., 2001, Int Panis et al., 2010). Indoor air pollution sources such as open fires, gas cooking, or poorly maintained gas appliances are also important contributors to the overall exposure that an individual may be subject to (Laumbach et al., 2015).

While government action is needed in order to tackle the current air pollution crisis, some studies have suggested that there are several choices that individuals can make in order to immediately reduce their exposure to air pollution and, therefore, reduce the risk of an adverse impact on their health (Holgate et al., 2016). Such choices include, for example, opting for a

running or walking route that avoids traffic, closing windows and setting the car's ventilation system to "recirculate" when driving along busy roads, amongst others (Laumbach et al., 2015). However, public understanding and awareness of air pollution remains low in comparison to other public health risks (Environmental Audit Committee, 2010). This is partly a reflection of undeveloped methods for information dissemination and public engagement. Hence, it is of particular importance that we identify engaging and effective ways to communicate the health risks of air pollution to the general public (Environmental Audit Committee, 2014). One strategy might be to enable people to "see" air pollution to encourage them to avoid it, but how can we "see" modern air pollution which, unlike the infamous London smog of the 1950s, is essentially invisible?

2.7 From fixed sites to monitoring sensors

The quality of the air has been traditionally assessed though fixed-site (continuous) air quality monitoring stations, placed at background sites or traffic hotspots. While this type of monitoring is effective, it is complex and expensive to install and maintain, therefore, limiting who gathers the data, why the data is gathered and how the data is accessed (Snyder et al., 2013). Furthermore, fixed-sites might not be representative of the actual air pollution exposure (Steinle et al., 2013) Local Authorities in the UK measure the air quality using continuous air quality monitor stations, which measure a number of pollutants including NO_2, O_3 and PM. During 2016, there were 284 monitoring sites across the UK (Department for Environment Food and Rural Affairs, 2017a). In London alone, the Air Quality Network (LAQN) comprises of over 100 continuous monitoring sites placed throughout the majority of London's 33 Boroughs. Local authorities supplement continuous monitoring stations with nitrogen dioxide diffusion tubes, which are placed at a large number of locations across the Borough. Although diffusion tubes are an easy and an inexpensive way to measure NO_2 concentrations over wide geographical areas, they only provide an average concentration over the exposure period (typically 4 weeks).

Advances in air pollution sensor technology, such as miniaturisation, reliability and economic accessibility, are increasing the feasibility of gathering real-time air pollution measurements at any location (Gabrys et al., 2016, Snyder et al., 2013). Furthermore, low cost, easy to use sensors have also given the opportunity for amateur users to carry out the own air pollution measurements, something that has traditionally only been performed by specialised scientists, following strict protocols. Whilst air pollution sensors have had limited use in academic settings, air pollution sensor technology has been well received by the general public and have been used by a number of organisations and community groups to measure the air pollution in and around neighbourhoods (Gabrys 2017, Lewis et al., 2016). While, these sensors cannot

replace conventional air pollution monitors, they do provide multiple benefits not only for increasing coverage of monitored areas but also for raising individuals' awareness of exposure to air pollution (Snyder et al., 2013). Whilst the opportunities offered by portable sensors technology seem evident, there is still research to be done in order to determine the reliability of many of these instruments (Lewis et al., 2016), Additionally, it has also been highlighted that to make this technology feasible to use in large populations, further sensor miniaturisation, longer battery life and further availability of cheaper but still reliable technology are required (Nieuwenhuijsen et al., 2014).

Several studies have used portable air pollution monitors and GPS tracking devices to measure individuals' exposure to a range of pollutants (Branco et al., 2014, Nieuwenhuijsen et al., 2015, Jeong and Park, 2017, Buonanno et al., 2013). Most of these studies focused on assessing exposure to air pollution, documenting the different activities and places where individuals were most likely to be exposed to high levels of black carbon (BC). Some of these studies highlighted the value of using wearable technology to document personal exposure to air pollution (Nieuwenhuijsen et al., 2015, Snyder et al., 2013) The use of these technologies potentially offers individuals and community groups the opportunity to gather personal exposure data at a specific location. This would make the data personal and relevant, allowing individuals to "see" where they are most or least likely to be exposed to air pollution, therefore supporting air pollution communication campaigns.

The interventions conducted during this thesis project involved the use of portable devices to measure the air pollution levels participants were exposed to as they went about their normal lives. The instruments used were black carbon aerosol monitors (Micro-aethalometer model AE51, Aethlabs, California, USA). The Micro-aethalometer has been used extensively across the world for air pollution exposure studies and has demonstrated robust performance against full size reference "gold-standard" instruments (Viana et al., 2015).

2.8 Actions to tackle air pollution

Despite steady improvements in air quality in the UK, currently over 270 Local Authorities - (71%) of those in the UK have declared one or more Air Quality Management Areas (AQMAs). The large majority of these AQMAs have been declared in urban areas where road transport has been identified as the main source of air pollution, accounting for 96% of the AQMAs declared for NO_2 and for 76% of those AQMAs declared for PM_{10} (Defra, 2017a).

In order to tackle the air pollution problem particularly in regard to NO_2 (the only statutory air quality obligation which the UK is failing to meet), the government has adopted a number of

regulatory and prevention measures which include: the Implementation of Low Emission Zones (LEZs), defined as an area which can only be entered by vehicles which comply with certain emissions standards, therefore, encouraging vehicle fleet turnover. Cities such as London, Oxford, Norwich, Brighton and Hove have now LEZs in place. The UK government has also invested in retrofit technology and accreditation, and in the promotion of initiatives such as technological change and cleaner vehicles to reduce emissions from transport. Initiatives that support and encourage changes in behaviour such as adopting more sustainable travel choices (e.g. cycling and waking) have also been embraced. Additionally, the UK government has also since 1997 established the 'air quality grant scheme' to support LAs to make air quality improvements and meet their statutory duties under the Environmental Act 1995 (Defra, 2017b). This scheme has awarded over £52 million in funding to a variety of projects, such as monitoring installation, electric charging points, awareness raising campaigns and clear air zones feasibility studies.

In the UK, London has been leading the way in tackling air pollution by adopting further bold measures such as charging the oldest, most polluting vehicles for entering central London through the "T-Charge" and developing plans to introduce an Ultra-Low Emission zone (ULEZ) where vehicles that do not meet exhaust emission standards (ULEZ standards) will be subject to a daily charge to travel through certain areas in the capital (Greater London Authority, 2010).

The Government has also recognised that it is essential to provide the public with the necessary information so they can make informed choices to tackle the sources of and reduce exposure to air pollution (House of Commons, 2018). However, it could be argued that this itself could be a specific political strategy, aimed at providing citizens with information about risk, so citizens can make a choice. Pollution exposure therefore becomes citizens' choice (fault), not government's choice (fault). Some of the government strategies to inform the public include near real-time air pollution monitoring and forecasting information, which is available free of charge to the general public. This information is disseminated using social and other media highlighting high air pollution episodes (Defra, 2017b). In London notifications about high and very high pollution episodes are now being displayed at tube stations, bus stops, river piers and digital signs along mayor roads. Air pollution information forecasting is accompanied by advice to take some sort of action, for example, during a "high" air pollution episode, adults and children with lung problems are advised to reduce strenuous physical exertion, particularly outdoors. Advice is tailored to specific groups (at risk individuals and the general public). In relation to this, Kelly et al (Kelly et al., 2012) have argued that the idea behind this approach is that there is a greater likelihood of motivating changes in both individual behaviour and

public policy if the public are made aware of: (i) variation in the air quality (air pollution forecasting), (ii) the harmful effects of air pollution on health and the concentrations at which these effects area likely to occur and (iii) practical actions which individuals can adopt to reduce their exposure to harmful pollutants.

While the government's steps to raise air pollution awareness may be heading in the right direction, communicating air pollution as a health risk to the general public can be a challenging affair (Beaumont et al., 1999) due to its invisible and odourless nature. Therefore, in order to complement the provision of information currently in place, which, on its own, is insufficient to change behaviour (Skov et al., 1991, Bush et al., 2001, Beaumont et al., 1999), it is necessary to develop effective methods of engagement to inform people of the dangers of air pollution as well as the choices that individuals could adopt to reduce their personal exposure to harmful pollutants. Given the invisible nature of modern air pollution, London provides an ideal setting for trying out methodologies that could aid air pollution communication efforts among the general public.

2.9 Public perceptions of air pollution

More than 90% of people worldwide live in areas exceeding the WHO Guidelines for healthy air (Health Effects Institute, 2019). In response to these challenges, government agencies, local administrators and Non-Governmental Organisations around the world have developed among other actions, initiatives to communicate air pollution to the general public. However, there are few studies that examine people's perceptions to information, either to reduce personal risk or to reduce their own contribution to the problem (Semenza et al., 2008). This final section will provide a background on what we already know in terms of public perceptions of air pollution, outlining some of the existing literature on perceptions of air pollution and findings produced by research commissioned by governmental and non-governmental organisations on public views of air quality.

Technological solutions to improve air quality are becoming more challenging. For many years, legislation has put the burden of air quality improvement on the automotive and energy industries to reduce emissions. In the past, they've done this with technological solutions (e.g. scrubbers, fuel quality etc.,) but they are running out of financially viable options. Therefore, understanding public attitudes and public acceptability of policy options for environmental improvement are becoming more important. Furthermore, it is only through this understanding that the risks associated with air pollution can be effectively communicated to the general public (Saksena, 2011).

Some of the earliest attempts to capture people's views and perceptions on air pollution date from 1950s-1960s studies conducted in the United States using public opinion surveys (Degroot et al., 1966, Schusky, 1966). The aim of these studies was to assess residents' air pollution awareness and concerns. In the UK most of the early research aiming to assess the public's views of air pollution was carried out post implementation of the Clean Air Act of 1956 (Bickerstaff and Walker, 2001) which provided for the establishment of smokeless zones on a national scale, and which provided subsidies to households to convert to cleaner fuels. An example of this is a study conducted in Sheffield (G. Wall, 1974), which focused on the public's perceptions of air pollution, knowledge and views on the current legislation and control measures and attitudes towards further abatement strategies. The findings from this study highlighted that although there was a high level of air pollution awareness among respondents, there was limited concern for the problem and skepticism on the effectiveness of individual actions to tackle the issue. The authors suggested that the findings could be attributed to the perceived air quality improvements and the perceived idea that the problem was under control following the adoption of more stringent legislation. The authors also suggested that the positive remarks from the press regarding air pollution improvements could have also influenced the respondent's views (G. Wall, 1974).

During the following decades, studies investigating this topic were limited, and it has been suggested that the lack of interest for this type of work could be attributed to policy makers and researchers paying more attention to what could have been perceived as more pressing environmental issues such as climate change, acid rain, pesticides, etc. (Bickerstaff and Walker, 2001, Saksena, 2011).

Studies commissioned by the Defra, have also shed some light on the emergent publics views on air pollution. In 2006, People Science & Policy Ltd (PSP), on behalf of Defra, assessed public views on air quality. This study comprised a literature review and a Citizen's Jury' composed of twenty-two residents (People Science & Policy, 2006). The jury was asked what improvements they would like to see in air quality and how these should be achieved. At the initial hearing the jury revealed that their understanding about air pollution causes, effects and mitigation measures was minimal and requested more information. After receiving information, the jury compiled a list of recommendations for Defra which included: the use of a portable 'meter' that could measure the quality of the air as individuals go about their normal daily routine, as this could help individuals make informed choices to reduce air pollution exposure. They also recommended that information about air pollution should always be accompanied with advice for reducing exposure to harmful pollutants. The report highlighted that the jury's desire for seeking information might have been driven by their sense of personal

accountability and that very few members of the jury would have independently sought information about air pollution. In another study commissioned by Defra in 2014 (Kilbane, 2014) which aimed to develop resources to help public health teams to communicate air pollution risks with local decision makers and the general public, found that there were low levels of air pollution health risks awareness among participants, but a firm desire to obtain additional information and advice on the topic.

The findings from these Defra studies are not unique, similar results were also reported in social surveys and workshops results (Bickerstaff and Walker, 2001, Beaumont et al., 1999, Bickerstaff and Walker, 1999). These studies highlighted the public's demand for regular access to clear and meaningful air quality information contextualised in relation to their daily lives.

In 2011, Saksena, categorized and provided some examples of the emergent literature of the late 90s and early 2000s on public perception of air pollution, into two categories (i) studies aimed at providing information to improve official risk communication (Beaumont et al., 1999, Cole, 1999, Howel et al., 2003) and (ii) studies that focused on the social aspects that could influence risk communication (Bickerstaff and Walker, 2001, Bush et al., 2001). Saksena also highlighted that there was a lack of research focused on: (i) the public perceptions of government and policy responses, (ii) the changes on public perceptions over time across a range of stakeholder groups and (iii) research which could convey the perspective of findings conducted by interdisciplinary teams, composed of social scientist and natural scientist.

Most of the recent research conducted on the public's views of air pollution has focused on assessing the impact that air pollution forecasting information and the associated dissemination modes have had on the public's perceptions of air pollution (McLaren and Williams, 2015). While governmental and non-governmental organisations have been interested in identifying what people's views are regarding the current air pollution situation and current government efforts to tackle the issue. For example, a study conducted by the European commission surveyed 25,525 European citizens from all 27 European Union Member States, aged 15 and above, sought to provide an insight into the European public views on air quality and pollution. Amongst other findings, the survey revealed that 56% of those surveyed thought that air quality had deteriorated in the previous 10 years, with 72% saying that the public authorities were not doing enough to promote good air quality (European Commission, 2013).

In the UK, results from a recent YouGov poll commissioned by the Greater London Authority (GLA) based on interviews with 1,000 London residents aged (18+), found that 88% of those polled thought that poor air quality in London was "a big problem", with 66% considering that the poor air quality issue was of particular significance in their local area. More than 72% of

the respondents said that the Government should be doing more to tackle the air pollution problem (YouGov, 2017a). A similar study commissioned by the environmental law organisation Client Earth as part of their 'Healthy Air Campaign' canvassed the views of air pollution from 1,670 adults from England, Scotland and Wales. The survey found that 42% of responders thought that over the last eight years, air pollution in the UK had become 'more of a problem', 10% thought that it had become 'less of a problem', while 31% said that they did not think that there had been a 'real change'. The survey also found that 58% of those surveyed considered the current levels of air pollution in the UK to be either harmful or very harmful to health, a figure that increased to 73% among Londoners. Additionally, 65% of those surveyed said they would support a new Clean Air Act in order to reduce air pollution, with almost 50% of the respondents supporting the banning of diesel vehicles from areas with high levels of air pollution (YouGov, 2017b).

Children's views towards air pollution have also been surveyed. A YouGov poll commissioned by the UK sustainable transport charity 'Sustrans' surveyed over 1,000 children age 6 to 15 years old and they found that 43% of the children surveyed were concerned about air pollution around their school, while 34% argued that the government was responsible for reducing air pollution and 29% believed that drivers were most accountable (Sustrans, 2018). Further YouGov work commissioned by Client Earth surveyed 1,612 British adults during December 2017 with the aim of assessing if there had been an increase in air pollution awareness over the last 12 months. The study found that about one fifth of the respondents (n=302) believed that their awareness of the issue had increased. From this, 75% attributed this increase to gaining more information about the issue in the media, 'reading and watching the news', while 30% said that their increase in air pollution awareness was attributed to receiving more information about health implications and 26% suggested that it was due to actions of campaigning groups (YouGov, 2017c).

The public's responses to the surveys described above could have been influenced by a number of factors such as (i) the UK's failure to comply with the EU regulations which has not only prompted court cases against the UK government, but it has also spawned much media coverage, (ii) an increase in awareness campaigns led by government and non-governmental organisations, and (iii) the 'Dieselgate' scandal (Brand, 2016).

While these surveys provide an overall indication of the views held by members of the public about air pollution, they do not provide information about why people responded the way they did. Furthermore, these surveys provide limited information about the characteristics of the respondents, therefore, putting into question whether the respondents were an actual representative sample of the population targeted, or merely a group of enthusiastic and knowledgeable individuals.

During this study, through a combination of qualitative and quantitative methods (observations, interviews and surveys), I provide in-depth insight on the air pollution views and perceptions of specific members of the community and the social context in which these narratives have been constructed. This offers unique information about why people say what they say about air pollution and about the extent to which they understand the problem.

It has been suggested that the public's understanding of air pollution remains patchy and that the urgency for taking action has not yet been sufficiently conveyed (Environmental Audit Committee , 2014) (Q38). Thus, the question of how we can we effectively harness public concern into action, amongst a public of heterogeneous nature and for whom tailored information and/or advice is needed (Beaumont et al., 1999) still remains. Furthermore, while the dangers and risks posed by air pollution are well documented, very few studies have addressed the public's perceptions of urban air pollution (Saksena, 2011) especially with regard to the extent to which people's social contexts influence the way people think and feel about it. This thesis endeavours to contribute to the current state of knowledge in this area by providing a picture of how Londoners from a range of community groups who took part in a community-based participatory research intervention view and perceive air pollution. This will be done in order to assess the value of community-based approaches and wearable technology as methods of engagement with community groups to improve the local environment and public health.

Chapter 3 - Methodology

Introduction

The purpose of this chapter is to describe and explain the methodology employed in this study. The first part of this chapter begins by presenting the underlying ontological and epistemological considerations. The second and third parts discuss the methodological approach adopted throughout this study. This chapter also provides a literature review in regard to the historical perspectives on participatory research (PR), the different types of PR and the challenges likely to be encountered when conducting PR. The final part of this chapter highlights the extent to which this approach has been used in the field of air pollution.

3.1 Ontological and epistemological considerations

When conducting any research, it is important to begin by understanding the philosophical assumptions underlying the study as these will shape the way in which the research is undertaken and the choice of methods employed for gathering the necessary information to answer the research question (Creswell, 2013, Grix, 2002). Philosophical assumptions such as those of an ontological (what is there to know?) (Hammond, 2013) and epistemological (how do we come to know what we know?) nature are considered in this section.

Ontology is the study of being and it relates to the nature of reality and its characteristics (Creswell, 2013). In one view, there is an objective reality that is present (the physical world) and exists independent of the observer, commonly associated with a positivism approach which deals with verifiable and measurable variables (Hammersley, 2007). Alternatively, there is a subjective reality (the meaning we assign to things) rooted in an anti-positivism (interpretivist) approach which deals with perceptions rather than objective truths (Hammond, 2013, Creswell, 2013). My academic background in environmental science and subsequently my work as an air quality consultant working in the area of air pollution modelling, meant that my understanding of knowledge has been constructed primarily under a positivist approach, where finding the relationship between measurable variables was the main objective. If I had based my research question solely as an environmental scientist, my epistemological assumptions would have been mostly limited to quantifying the levels of air pollution exposure and their effects on health framed by my understanding of ‘air pollution as a health risk’. This would have been based in an ontological belief that air pollution is a major environmental risk to health.

Qualitative research techniques, although well documented, still face some scepticism by those rooted in other research traditions (Lambert and McKevitt, 2002, Green, 2009). Coming from an academic background based on a positivist approach, meant that at the beginning of my research, the idea of having a dialectical research approach which would be flexible and adaptive was unfamiliar to me and to many members of my research group. Not having a hypothesis to be tested was always a matter of discussion at my thesis committee meetings, especially at the beginning of my PhD. Soon after finishing my three months of social science research methods training, it became apparent that alternative ontological and epistemological perspectives might need to be adopted in order to answer this study's research question. It was then, through the development of my PhD, that I came to appreciate the importance of being able to view reality in different ways and to understand that there are different valid methods of gathering knowledge.

Therefore, the ontological position for this study is that, when assessing the impact of interventions which involve the participation of people, it is necessary to take into account and explore "elements" that are not objectively present. The epistemological position is that these "elements" cannot be measured or manipulated and that observational qualitative research methods must be used.

3.2 Methodology

The research question that underpins this study is, "Can community-based participatory research interventions, which involve the collection of personalised data (air quality data), be used to aid the development of effective methods of engagement with community groups to improve the local environment and public health?" Qualitative methodologies that seek to explore knowledge, beyond numbers and measures, are better suited for investigating certain questions such as those related to the use of participatory research approaches as tools for communicating air pollution as a health risk. These methodologies may help to answer several questions including the following: Why do people decide to take part? What is the context and how do situations develop during each of the project stages (e.g. the recruitment of participants, the air pollution monitoring and the results feedback)? How do people respond to the air quality data gathered? What is the impact that personalised air quality data has on participants' practices? Interpretative questions that explore the 'how' or 'what' rather than the 'how many' or 'how much' can be better addressed with a qualitative methodology (Green, 2009).

3.2.1 The ethnographic approach

The term ethnography is derived from the Greek words 'ethnos' (people) and 'grapho' (to write). Therefore, ethnography can be defined as 'writing about people' (Hammond, 2013). Ethnography involves having direct and continued contact with human actors while they go about their everyday lives, observing what happens, listening to what is being said and asking questions that could provide some information regarding the research phenomenon studied (O'Reilly and Bone, 2010). Ethnography is said to be an iterative-inductive approach, where research is fluid and flexible (O'Reilly and Bone, 2010). Ethnographers aim to explore the field of study with as few preconceptions as possible so they can view the studied phenomena with an open mind. However, while it is not entirely possible to withdraw preconceived ideas and expectations, ethnography accepts the fact that those ideas exist and actively reflects on how these preconceived ideas could impact the research (O'Reilly and Bone, 2010). Ethnographic studies seek to describe the understandings and meanings constructed by people within their natural settings and these studies normally extend over long periods of time in order to get a better understanding of social structures (Green, 2009). However, based on their own time spent in the field, Jeffrey and Troman (2004) argued that, ethnography does not always necessarily need to be carried out over long sustained periods of time. Instead, they proposed three different time modes: compressive time mode (short period of intense research), a selective intermittent time mode (flexible approach to site visits) and a recurrent time mode (same temporal phases sampling).

This study was influenced by an ethnographic approach (Atkinson, 2001 Brewer, 2000), based on Jeffrey and Troman's 'recurrent time mode'. Field notes were documented during each of the project stages in order to capture how situations developed (e.g. the recruitment of participants, the air pollution monitoring and the results feedback). This approach allowed me to document the experiences of individuals when taking part in a participatory research intervention by observing them in their normal settings, while the air pollution projects were taking place. By using ethnography in this study, I was able to explore participants' practices, discourses, own interpretation of events, and to examine why people do and say particular things, rather than what they say they do (Hammond, 2013 O'Reilly, 2009) (as one might get with interviews alone).

The main method of ethnography is participant observation[1] and involves the researcher entering the field of study while making written and mental notes in order to provide some

[1] When describing research methods, the term 'ethnography' is often used interchangeably with "participant observation (Green, 2009).

insight into what does go on in everyday settings (Green, 2009, O'Reilly and Bone, 2010). Ethnographic studies generally also involve the use of other methods such as surveys and interviews (Grbich, 1999, Hammersley, 2007), which together with the participant observation method will be discussed in detail in Chapter 4 - Methods.

3.2.2 Positionality and reflexivity

When adopting interpretative perspectives such as the ones followed in this study, it is essential for the researcher to be open and transparent about how the research was carried out. Who you are and where you are as a researcher would inevitably shape the design and outcomes of the study (Green, 2009).

My approach to entering the field of study (community groups settings) varied from site to site as described in the following chapter. However, I always introduced myself to the community groups as an air quality scientist. Community group leaders (gatekeepers) saw me as the 'expert' and that is how they introduced me to the community group members. My position as the 'expert' meant that throughout this study, I was doing more than just observing the development of the air pollution projects. I was also often being asked by participants to comment and/or to give advice about various air quality issues.

While positionality refers to what we know and believe, reflexivity involves examining one's own views and practices of what we know and believe, and reflecting on how these may have influenced the research (Hammond, 2013).

As data are 'produced' rather than merely 'collected' (Green, 2009), it is important to acknowledge and actively reflect on how my position as an environmental scientist, enthusiastic about environmental issues, could have influenced the development of this study and/or the data produced. For this purpose, throughout this thesis, I will present a process of ongoing reflection about my own interpretation of how situations took place, making explicit the occasions when I think my intervention may have, to some extent, influenced this study.

3.3 Ethnography and participatory research

The present study combines the use of two different methodological approaches: ethnography and participatory research. Historically, the main purpose of classic ethnographic studies is to present a realistic account of the social phenomenon under study, rather than addressing the local needs of the community and/or using the research findings to produce social changes (Hammersley, 2007). Participatory research, on the other hand, has been characterised by focusing on producing knowledge for social change (Roncoli, 2006). However, recently,

ethnography and participatory approaches have been recognised as interwoven practices where ethnography is acknowledged not only as a descriptive methodology driven by a particular agenda, but also as an approach that has the potential to change practice (Mesman, 2007).

Throughout this study, ethnography is used as a data-gathering methodology providing insights into cultural meanings and local priorities identified during the development of the air pollution monitoring projects. Participatory research, on the other hand, is used as a methodology for getting communities involved in the design, implementation and dissemination of their own air pollution monitoring projects. The aim of employing these two methodologies is to shed light on how people understand and perceive air pollution, and on how community-based projects impact people's perceptions and attitudes towards air quality issues.

The following section reviews the literature in regard to participatory research's origins and key principles.

3.3.1 Participatory research

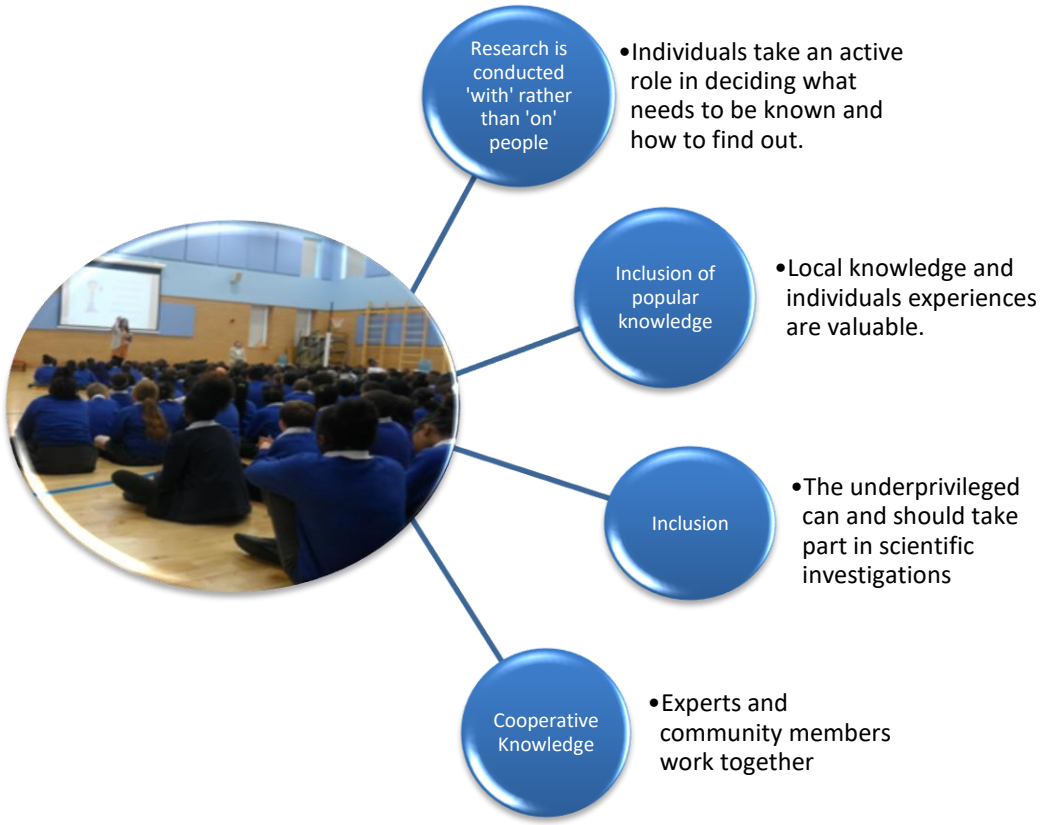
Participatory approaches are often rooted in an epistemological critique of positivist methods, which is an approach to knowledge based in what early social scientists saw as the methods of the natural sciences (Green, 2009). A positivist philosophy is one that assumes that reality can be measured, variables can be controlled, captured and manipulated. The main purpose of a positivist approach is the verification of facts. Participatory enquiries, on the other hand, follow an interpretative approach, which assumes that people can construct their own reality and that there are multiple realities, where variables cannot be controlled and should only be described.

While main stream research generates knowledge for understanding and this knowledge is normally controlled by a small elite of scientists detached from the wider society, participatory research focuses on cooperative knowledge for action (Cornwall and Jewkes, 1995). Participatory research focuses on researching with people rather than on them and it differs from conventional rigid research by being reflexive, flexible and iterative (Cornwall and Jewkes, 1995).

Approaches which aim towards a more collaborative research process include: Participatory Action Research (PAR), Public Participation in Scientific Research, Popular Epidemiology, Community Based Participatory Research (CBPR), Community Capacity, Street Science (Corburn, 2005), Popular Education, Citizen Science, Photovoice (Povee et al., 2014), among others (Hughes, 2008a, Waterman, 2001, Corburn, 2005, Dick, 2006, Heron, 1996, Schein, 2008). These various approaches and terms often blur and to define each precisely is challenging yet many of these approaches are rooted in a series of common principles influenced by the Brazilian educationalist Paulo Freire's work in education and empowerment

in the 1970's (Cornwall and Jewkes, 1995). The earlier work of Kurt Lewin who coined the term 'action research' in 1940s (Lewin,1946) had also influenced what is currently referred to as participatory research.

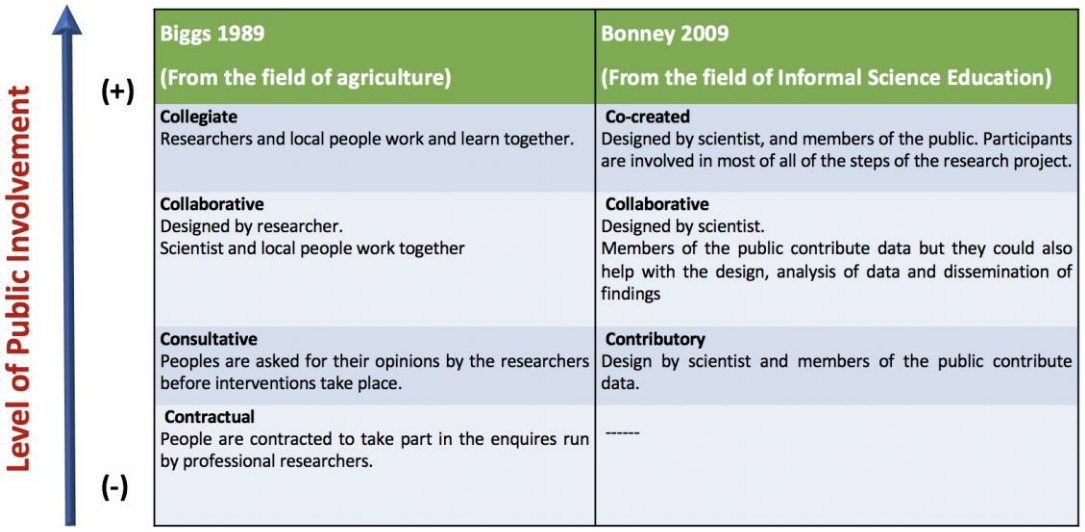
Freire argued that education should be empowering and liberating and that a continuous learning process will allow learners to use this knowledge to transform their own living conditions and those of their communities by taking ownership of their own reality and the world around them (Freire, 1990). He believed that education would stimulate action, which is then shaped by reflection and leads to further action. He also argued that research should not only be carried out by specialists, but that everyone can and should be part of the research process as people's own knowledge is unique and valuable (Freire, 1990, Green, 2009, Cornwall and Jewkes, 1995). Figure 3-1 below illustrates some of the elements normally present in participatory research approaches which have been embraced in this study throughout the development of each of the air pollution projects.



Adapted from (Chambers, 1997)

Figure 3-1 Participatory Research Components

While most participatory research approaches share the same participatory ethos highlighted in the Freirean philosophy, participatory approaches normally differ on the level and magnitude of participant engagement. Andrea Cornwall and Rachel Jewkes (1995) argue that what distinguishes participatory research from conventional research is the "location of power in the research process". They suggest that researchers tend to use four modes of participation in the research process (drawing on the work of Biggs 1989), as presented in Figure 3-1. This model highlights the relationship between participation and control. Cornwall and Jewkes argued that linear research tends to maintain the level of control, while participatory research is flexible and transformative. Similarly, Bonney 2009 writing from the field of 'Informal Science Education (ISE)' classified the different levels of public involvement based on the location of power during the research process. Figure 3-2 shows these two participatory research classifications, which have been dictated by the level of public involvement in the scientific investigation.



Biggs 1989 (From the field of agriculture)	Bonney 2009 (From the field of Informal Science Education)
Collegiate Researchers and local people work and learn together.	**Co-created** Designed by scientist, and members of the public. Participants are involved in most of all of the steps of the research project.
Collaborative Designed by researcher. Scientist and local people work together	**Collaborative** Designed by scientist. Members of the public contribute data but they could also help with the design, analysis of data and dissemination of findings
Consultative Peoples are asked for their opinions by the researchers before interventions take place.	**Contributory** Design by scientist and members of the public contribute data.
Contractual People are contracted to take part in the enquires run by professional researchers.	------

Adapted from (Green, 2009, Cornwall and Jewkes, 1995, Bonney, 2009)

Figure 3-2 Level of public involvement in research

The level of participant involvement in the research process will dictate how and by whom the research is carried out at each of the different stages (e.g. design, data-gathering, data-analysis and dissemination). Participatory research interventions are generally carried out in community settings where research is conducted cooperatively in order to yield wider benefits for all those taking part. The term "community" commonly indicates a variety of cultural, social or geographical groups (e.g. school, work place, and neighbourhood), which share common values or interests, such as religious beliefs, political systems or geographical settings and which work together to achieve common objectives (Schiavo, 2013). Participation is an

essential part of human nature, an ontological given, and when individuals take an active role in the community, they become part of the whole, working towards a common goal instead of separate entities in isolation (Heron, 1996).

In the area of health care, participatory research is also known as 'community mobilisation (CM)', and has been identified as a key area of health communication where participation and ownership of the health communication interventions have the potential to yield positive long-lasting changes (Schiavo, 2013). Drawing on the Freirean emancipatory model CM aims to provide opportunities for marginalised communities to take control over their health by being able to understand the sources of their health problems and identify and demand solutions to improve their well-being (Campbell, 2014).

3.3.2 Participatory research models

This section reviews a number of participatory research approaches that have emerged over the last two decades. This section also highlights some of the common principles shared between the different approaches and explains how some of these principles have influenced the design and development of this study.

Popular education also known as Freirian and empowerment education has been used widely in the field of education creating more equitable conditions around the world for 50 years (Wiggins, 2012). This approach rooted in Freire's emancipatory model for education, emphasises that individuals should not be treated as "empty vessels" who need to be filled with information, but rather as active agents of their own learning, capable of achieving critical consciousness in order to generate change (Freire, 1990). The idea of filling individuals with information, is an approach often still followed by governmental institutions and NGOs which tend to assume that more awareness will lead to more pro-environmental behaviour (Kollmuss, 2002). It has also been argued that while information may raise awareness and concern, persistent changes in practice are still lacking (Ortega-Egea et al 2014). During this research study, drawing on Freire's emancipatory model for education, participants would not only be provided with information about air pollution causes and effects, they would also have the opportunity to be active agents who would gather their own air pollution data to learn about the environmental conditions (air quality) around their neighbourhoods.

'Participatory Rural Appraisal' (PRA) is commonly used by non-governmental organisations (NGOs) in the field of rural development. This approach originally emerged as the Rapid Rural Appraisal (RRA) concept that appeared in the late 1970s and, as well as other approaches such as Rapid Epidemiological Assessment, Rapid Ethnographic Assessment and Rapid Assessment Procedures, focused on involving people merely as informants (Cornwall and

Jewkes, 1995). In the late 80s and early 90s, influenced by a number of participatory approaches, RRA developed into what is nowadays known as PRA.

Participatory Rural Appraisal differs from its predecessor in that local people are actively involved in the research process and outsiders act only as facilitators (Chambers, 1994). One of the early pioneers of PRA, Robert Chambers, argues that rural projects should be community-driven, allowing people to be involved in the designing, development and management of rural programs. Chambers highlights the Freirean idea that research should be done 'with' rather than on people so they can take ownership of their own reality and the world around them (Chambers, 1997). This thesis embraces this idea and through the adoption of a participatory approach aims at enable participants to be involved in the knowledge-production process.

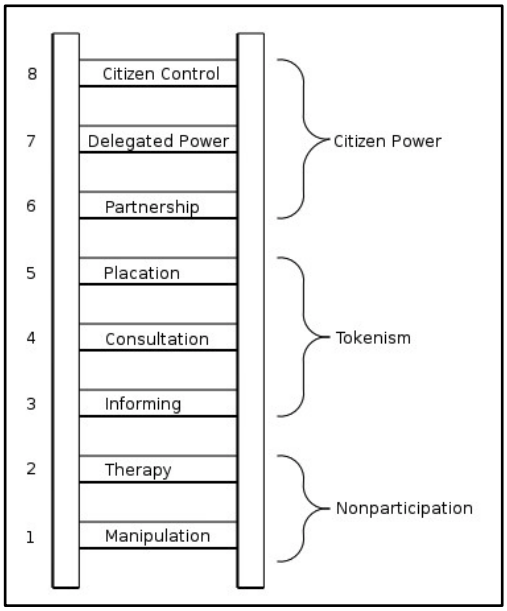
Citizen science is an idea that is not new. For centuries, citizens have been observing, recording and analysing data of the natural world around them without any formal qualification (Miller-Rushing et al., 2012). However, as stated in a report for the European Commission by the University of the East of England's Science Communication Unit, "It is the professionalisation of science that has led to the exclusion of citizens" (European Commission, 2013). The term Citizen Science first appeared in Alan Irwin's book 'Citizen Science' in 1995, where he uses this term to describe the expertise owned by 'lay people"(Irwin, 1995). Around the same time, American researcher Rick Bonney used the term 'citizen science' to refer to public participation in scientific research (Bonney, 2009). More recently Miller-Rushing defined citizen science as "The engagement of non-professionals in scientific investigations" independent of the nature of this involvement (Miller-Rushing et al., 2012).

Most formal citizen science projects are of contributory nature, designed and run by scientists, and citizens act as "contributors" (Bonney, 2009, Wildschut, 2017) with different scientific, educational and engagement objectives. Citizen science interventions make possible the gathering of large data sets, something that would be difficult to achieve by professional science alone (Miller-Rushing et al., 2012). The wider spread of technologies such as smart phones, sensors, and the internet have presented an opportunity for increase accessibility and remote participation from citizens in science projects (Graham et al., 2011, Nature| Editorial, 2015, Bonney et al., 2014, Wildschut, 2017, McCrory et al., 2017), offering the opportunity to collect large sets of data at a lower cost, allowing for research to be carried out under tighter budgets.

Citizen science interventions are characterised by not only providing benefits to scientists, research groups and funding institutions, but by also providing an opportunity for the public to actively engage in scientific investigations, therefore, improving citizen's literacy and nurturing their curiosity in science, (Miller-Rushing et al., 2012). Despite the informal nature of many of the citizen science projects, citizen science interventions have been increasingly appearing in peer-reviewed journals indicating the wider use of this approach and its acceptance by the scientific community (Follett and Strezov, 2015, Bonney et al., 2014).

The context and level of engagement in citizen science projects tend to be varied. The simplest categorisation refers to Bonney's (2009) model of 'levels of public involvement' (Table 3-1), based on the structure of participation and the involvement of the public at each of the different stages of the research process. However, Hakaly (2013) had expanded and restructured Bonney's classification with a four-level model, defining the least level of involvement as "crowdsourcing" where participation is limited to providing resources such as computing or carrying sensors, and the highest level of involvement defined as "extreme citizen science" with total participation in the research process including problem definition, data gathering and data use and dissemination (Haklay, 2013, Sheldon and Ashcroft, 2016).

Citizen science has also been influenced by Arnstein's (1969) ideas on public participation (Haklay, 2013) based on her experience at the US Department of Housing and Urban Development (HUD). For Arnstein, 'citizen participation' is 'citizen power', which allows citizens to have an active and decisive role in economic and political processes. This model was conceived in the context of urban development but has been adjusted and used in other areas (Arnstein, 1969). Arnstein proposed a typology with eight levels of public participation, each based on the extent of citizen power, from manipulation to citizen control, divided into three different categories: citizen power, tokenism and non-participation (Figure 3-3).



Source: (Arnstein, 1969)

Figure 3-3 Arnstein's ladder of participation

Citizen power refers to an increased degree of influence on decision-making, while tokenism refers to a state where the public can express their views and their views are heard but where there is no assurance that their views would be taken into account. The non-participation category at the bottom of the ladder describes levels that may be seen as participatory but are in fact methods for educating and influencing people's views and interests (Arnstein, 1969). The "extreme citizen science" where the research process is shaped by the participants can be compared to the "citizen power level" from the Arnstein categories of participation. While the aim of this thesis is to get participants involved in all parts of the research process the extent to which this participation takes places may differ at each community group and from each individual participant. It is possible that participation by the different actors involved in this study would fluctuate through different levels and at different points through the research. Therefore, while the participation of the research partners is conceptualised in different ways, it converges into the participatory research paradigm.

Citizen science engages volunteers in a wide variety of projects, including:

- Classifying images such as the Galaxy Zoo project, an online platform where thousands of volunteers visually inspect and classify pictures of galaxies helping astronomers to study the universe (Smith et al., 2011).
- Monitoring wildlife, such as the eBird project, an online tool where thousands of citizens from expert bird watchers to amateurs report and access information about birds in order to help biologists to identify and conserve birds habitats (Sullivan et al., 2009).

- Identify sources of pollution such as 'The Globe at night' project which enable citizens around the world to quantify and report light pollution levels locally in order to promote awareness of the impact of artificial light (Sibylle et al., 2016, Kyba et al., 2013).

While the benefits of using this type of participatory research approach might seem obvious, researchers who decide to use a citizen science are often questioned about the reliability and robustness of the data collected and the participant's genuine motives for taking part as these may not truly represent the broader citizens' views (Nature | Editorial, 2015).

Participatory Action Research (PAR), is a participatory approach which aim is to make changes 'action' through understanding 'research'. PAR uses an iterative spiral process where research generates action, which is then reflected upon and redefined in order to determine which actions should follow (Baum et al., 2006). Participatory Action Research has been used widely across a variety of disciplines, including: education, industry and, more recently, health care settings (Hampshire et al., 1999). PAR has been used to carry out interventions which involved the active participation of individuals in order to promote change (Waterman, 2001, Hughes, 2008a). The cyclical nature of action research tends to increase understanding of the issue at stake, and confers flexibility and adaptability throughout the research process (Dick, 2003). Many scholars attribute the origins of Participatory Action Research (PAR) to Luke Lewin in the 1930's, in the USA. Lewin saw 'action research' as a way to get workers actively involved in their work context, stimulating leadership and participation. He believed that this approach would ultimately lead to greater productivity (Whitehead, 2006). Participatory Action Research is said to be an empowering process (Hughes, 2008b), which offers individuals the opportunity to participate in building wealthy and whole communities regardless of occupation, formal education or health status (Hughes, 2008b, Reason and Bradbury, 2008). PAR therefore, implies by definition, action and change, while the participatory approach adopted in this thesis focuses more on collaborative research activities where the emphasis is not on outcomes but on processes.

Community Based Participatory Research (CBPR), is a participatory approach based on the idea that research should be conducted in a way that benefits individuals through direct participation or by using the research findings to produce positive changes (Israel et al., 1998). CBPR emphasises that research should be carried out in a way where research subjects are transformed into researchers by involving individuals in the research process, e.g. in the design of the project, the analysis of the results, the implementation of the findings as well as the dissemination of the information and knowledge gained (Waterman, 2001, Israel et al., 1998, Corburn, 2005, Altman et al., 2008, Ramirez-Andreotta et al., 2014, S. Lazarus, 2012). One of

the strengths of using a CBPR approach is that the research is an empowering process where information is gathered in order to promote action (Israel et al., 1998), such as the case studies presented by Minkler 2008, where communities that were subject to the effects of various polluted conditions, generated environmental information and used it to improve environmental health decision making (Minkler et al., 2008).

As part of a multidisciplinary intervention, this research study embraces many of the key principles from the various participatory research approaches discussed above. However, this study differs from conventional participatory models in the level and magnitude of participant engagement that took during the different phases of the air pollution projects as, explained in the subsequent chapters. In practice, when carrying out participatory research, it is unusual to follow one rigid approach, flexibility and adaptability are often needed (Pain and Francis, 2003),. Furthermore, in comparison with most participatory research interventions where projects are normally carried out by teams of researchers, the participatory research projects presented in this thesis were carried out only by me (the researcher), adding further pressure on outreach capacity and time constraints.

Table 3-1 highlights the key characteristics of the participatory research approaches reviewed above. The participatory aspects taken into account for this thesis are highlighted in green.

Table 3-1 Participatory research approaches' key features
(Cells highlighted in green highlight those aspects embraced by this study

	Popular Education[a]	**Participatory Rural Appraisal (PRA)** [b]	**Citizen Science** [c]	**Participatory Action Research (PAR)** [d]	**Community Based Participatory Research (CBPR)**[e]
Effective Collaboration	Knowledge is constructed in the interaction between people	Research is managed and conducted by local people while outsiders act as facilitators	Often designed and run by scientist and citizens act as contributors	Actions are more likely to be feasible and effective if these actions/problem solving comes from the people affected	Involves collaborative partnerships
Active collection of data	People should be active participants, rather than passive recipients in their learning process	Community driven research	Makes possible the collection of large data sets	Individuals impacted by an action should be involved in practice	Shared control over all phases of the research
Inclusion	Promotes equitable conditions	Rural development field	Often conducted by white, educated, fairly affluent people	Practitioners in PAR are often professionals, while lay people are often the poor and people from racial minorities	Community members, particularly those for underprivileged backgrounds are crucial for the research
Empowerment	Individuals' are active agents of their own learning.	Encourage people to understand current conditions and identify suitable solutions	Improves citizen's literacy and nurtures their curiosity in science	Promotes conditions that foster empowerment	Empowering process that facilitates co-learning
Dissemination and Communication	Knowledge production	Disseminates findings and knowledge gained amongst involved communities	Usually disseminate research findings in the form of scientific publications	Disseminate conclusions/translate results into action	Disseminates findings and knowledge gained to all partners

a (Freire, 1990)
b (Chambers, 1994)
c (Irwin, 1995)
d (Whitehead, 2006)
e (Israel et al., 1998)

The following section highlights some of the main challenges commonly encountered when conducting participatory research.

3.3.3 Participatory research: The challenges

One of the main challenges encountered when conducting participatory research (PR) lies in the very participatory nature of this approach (Waterman, 2001). By involving participants in the research process, agendas and protocols are predisposed to be changed. The implementation of protocols and success of participatory interventions depend heavily on the extent of participants' involvement (Sîrbu et al., 2015). Community members' lack of experience in conducting research and adhering to protocols may become a barrier for completing projects on time (Mikesell et al., 2013).

Furthermore, as highlighted by Freire (Freire, 1998), there cannot be a "one size fits all" approach when conducting PR, as projects tend to be time and location sensitive. Therefore, programs must be adaptable and flexible. Participatory research is in essence a dynamic process which often requires continual reflection, assessment and, if needed, adjustment to research protocols (Mikesell et al., 2013). Another common challenge encountered when conducting participatory research, especially in academic settings, is the research proposal stage. By definition, this stage must be designed and submitted for approval to principal investigators, ethics committees and/or funding bodies before engaging with the targeted participants, meaning that those participants are excluded from this process (Southby, 2017). While participatory research approaches are normally characterised by their commitment to conducting research that would benefit those involved (Israel et al., 1998), informal PR interventions that are not carried out under the academic umbrella are not normally required to go through such rigid processes, and as a consequence they run the risk of not meeting basic ethics rules. However, participatory research advocates claim that the best way to ensure an ethical research is indeed to make the participatory research principles the core of the research (Mikesell et al., 2013).

3.3.4 Participatory research and air pollution

Participatory research methodologies have been used extensively in the air pollution field becoming an important tool for engaging with people into air pollution affairs, creating projects aimed to achieve social objectives. Participatory research projects have been reported in both grey and peer- reviewed literature (McCrory et al., 2017). Peer reviewed studies that have used PR include but are not limited to:

- Studies that investigated the extent to which vegetation can be affected by an increase in levels of air pollutants (Seed et al., 2013, Pescott et al., 2015).

- Studies that offered participants the opportunity to monitor air pollution at locations that are not covered by current monitoring efforts at a community scale (Snik et al., 2014, Commodore et al., 2017).
- Studies that focused on identifying sources of pollution and then used the information gathered as evidence to stimulate effective advocacy to eradicate health disparities (Minkler, 2010),
- Studies that highlighted the opportunities of using low-cost air pollution sensing devices and web based tools, where not only large amounts of air pollution data can be collected but where it was also possible to gather information about shifts in individuals' perceptions of air quality as a consequence of taking part in such interventions (Sîrbu et al., 2015, Commodore et al., 2017).
- Studies that aimed to utilise community assets to better understand residents' perceptions concerning local environmental and health issues in order to improve the health of the community (Corburn, 2005, Kondo et al., 2014). Other studies sought to enable citizens to use low-tech monitoring tools to understand and act upon environmental problems such as air pollution (Gabrys, 2016).

In 2017, Commodore et al, carried out a literature review on the motivations, approaches and outcomes of air monitoring studies which have incorporated participatory approaches. This review focused on studies conducted in the USA where participatory research has been used extensively. The review found that the main reason why people took part in the reviewed air pollution monitoring studies were concerns about the health risk posed by air pollution. Living near potential sources of pollution, perceived urban growth and lack of air pollution monitoring in residential areas were also identified as major concerns. The review also identified that, in general, participants were inspired to take part as they wanted to know more about air pollution. The review also found that the main outcomes of participatory air monitoring included: (i) lasting partnerships between the communities and academic institutions, the government and the industry, (ii) an increase in air pollution awareness, (iii) the development and implementation of measures and policies to tackle air pollution (Commodore et al., 2017).

Unpublished studies have also shown to be particularly useful to raise air pollution awareness and to provide citizens with the tools to be able to lobby decision-making authorities to take action to clean up the local air. Many of these PR projects are sponsored by a variety of organisations such as government and non-government institutions as well as social enterprises. For example in the UK non-governmental organizations such as Friends of the Earth, London Sustainability Exchange (LSx) and the social enterprise 'mapping for change'

support citizen science projects which give citizens the opportunity to measure local air quality in order to gather evidence to promote change (Friends of the Earth, 2018, Mapping for Change, 2018, London Sustainability Exchange (LSx), 2018).

While participatory research methodologies have been used extensively in the air pollution field particularly in the USA (Commodore et al., 2017), evidence about the impact that participatory research approaches using personal air pollution monitoring have had on those who took part remained scarce. This study aims to further contribute to this body of literature by adopting a participatory research approach to air pollution monitoring (researching with people rather than on people) while documenting the experiences of those who take part in the process. The findings obtained from this study will provide information about the extent of the impact that participatory approaches, using personal monitoring, can have on members of the community when used as strategies for communicating air pollution as a health risk to improve the local environment and public health.

Chapter 4 – Methods

Introduction

In this chapter I present a discussion of the methods used in this thesis to examine how access to relevant personalised environmental information (air quality data) gathered through community projects can be used to aid the development of effective methods of long term engagement with community groups to improve the local environment and public health. The first section of this chapter discusses the use of the participant observation method, followed by an overview of the study, the criteria used when selecting the four studied community groups and participants, and details of the ethical approval required for conducting each of the case studies. This section also provides information about how the projects developed at each of the four community groups before describing in detail the methods used: surveys, semi structured interviews and collection of other sources of data 'triangulation'. The final section of this chapter explains how the qualitative data were analysed.

The dynamic and iterative nature of this study mean that throughout this chapter the narratives tend to move forward and backwards between what was planned and what actually took place. The purpose of using this approach was to provide an accurate and transparent account of the development of the study.

4.1 Methods

The following section describes in detail the methods used for collecting and recording data during this study: participant observations, air pollution monitoring projects, surveys and semi-structured interviews.

4.1.1 Participant observation

As discussed in the previous chapter, this study adopted an ethnographic approach to data collection and this included the use of participant observation, which is considered as the main method of ethnography. This method involves the researcher joining the group, and in this particular study, participating in the intervention taking place, while observing, recording and trying to make sense of the actions and events happening (O'Reilly, 2009). Observational methods can record accounts of everyday life that may seem unimportant to participants and therefore could be left out in an interview. Furthermore, the use of participant observation in addition to interviews provides an opportunity to compare what people do with what they say they do (Lambert and McKevitt, 2002).

Observational methods also allow the researchers to document individuals' actions and their interactions with others in their 'natural' state (Hammond, 2013, Green, 2009). The strength of this approach is that it provides data on phenomena (such as behaviour) as well as on people's accounts of those phenomena (Green, 2009).

Classical ethnography was typically concerned with describing 'other' cultures, normally faraway away (Draper, 2015), where the researcher's role was limited to observing, reflecting and documenting details about the understandings and meanings constructed by people as they undertake their daily lives without having an impact on the setting (Grbich, 1999). Contemporary ethnography on the other hand has focus its research to settings near to home, with 'local' and 'near' communities (Draper, 2015) and it is characterised by the emphasis given to the discourses around the power relationship between the researcher and the researched participants (Grbich, 1999). Furthermore, in contemporary ethnography, the role of the researcher as participant observer has varied on a continuum from being actively involved in the research process to being strictly an observer (O'Reilly, 2009).

During the development of this study, I was mostly actively participating, providing participants with information and scientific expertise in regard to the air pollution data collection and analysis. The time I spent with each of the community groups and their members varied from group to group as I had to visit each group several times at different stages of the projects.

The active nature of my role implied that most of my field notes were written in private, as soon as I left the study site, normally on the bus or train on my journey back to my office. Consequently, my notes sometimes relied on my memory and on my own interpretations on how the events took place. The participant observations were transcribed in full and pseudonyms were used to safeguard the anonymity of participants. Figure 4-1 shows when during the projects participant observation field notes were collected.

4.1.2 Study overview

The study followed a participatory research approach endeavouring to get the study participants involved in all stages of the research process. First, to raise awareness and interest in the subject and hence in the project, participants were provided with information about air pollution causes and effects. Second, to stimulate exposure reduction, participants were invited to measure for themselves the levels of air pollution present in their area and then to discuss the implications of the data collected.

Aiming to follow a participatory approach, all study participants were encouraged to contribute to the planning and execution of the air pollution monitoring stage of the projects

(e.g. by deciding on the time and places where the air pollution monitoring would take place), as well as the dissemination of the results (e.g. by disseminating the projects results themselves and/or proposing ways in which the information could be disseminated). The participants' practices, discourses and my own interpretation of events throughout the air pollution monitoring projects were recorded using an ethnographic approach.

Four community groups across London were involved in the research:

- Primary School,
- Parent and baby group,
- Senior citizens group,
- Chronic Obstructive Pulmonary Disease (COPD) patient group.

Background detail of each of the community groups, their environmental, geographical and cultural setting is provided in Chapter 5 "Settings and participants".

The community air pollution monitoring projects took place over two years (Figure 4-1). The Primary school project was the first project to be carried out during the first half of 2015, followed by the parent and baby group project over the second half of 2015. The senior citizens project and the COPD project were carried out almost simultaneously during the first three quarters of 2016. During these two years, qualitative data on the impact that the participatory research approach had on participants' views and perceptions towards air pollution was collected using participant observations, surveys and interviews.

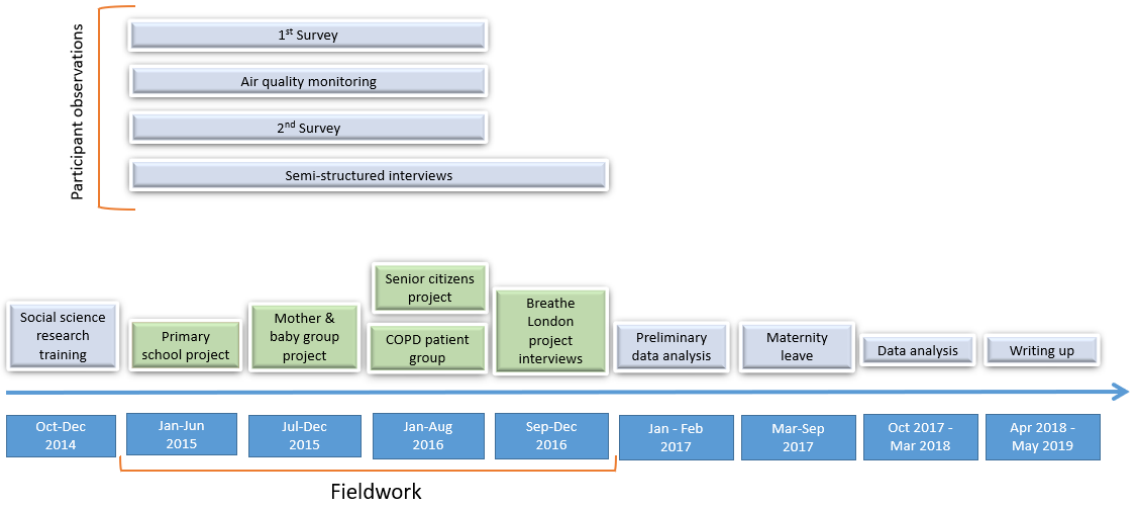


Figure 4-1 The research process

A study protocol is usually developed to guide and to make transparent the study being undertaken. A protocol is also a requirement when applying for ethical approval to conduct a study. During this study the development of a protocol was also necessary to gain access to

the groups, as it was essential to explain the stages and practicalities of the air pollution projects to each of the groups' gatekeepers in order to gain access. Due to the dynamic and iterative nature of this study the contents of this protocol had to be adjusted a number of times in order to satisfy the individual requirements and needs of each of the community groups. Figure 4-2 shows the generic study design used for the study protocol and highlights some of the main modifications.

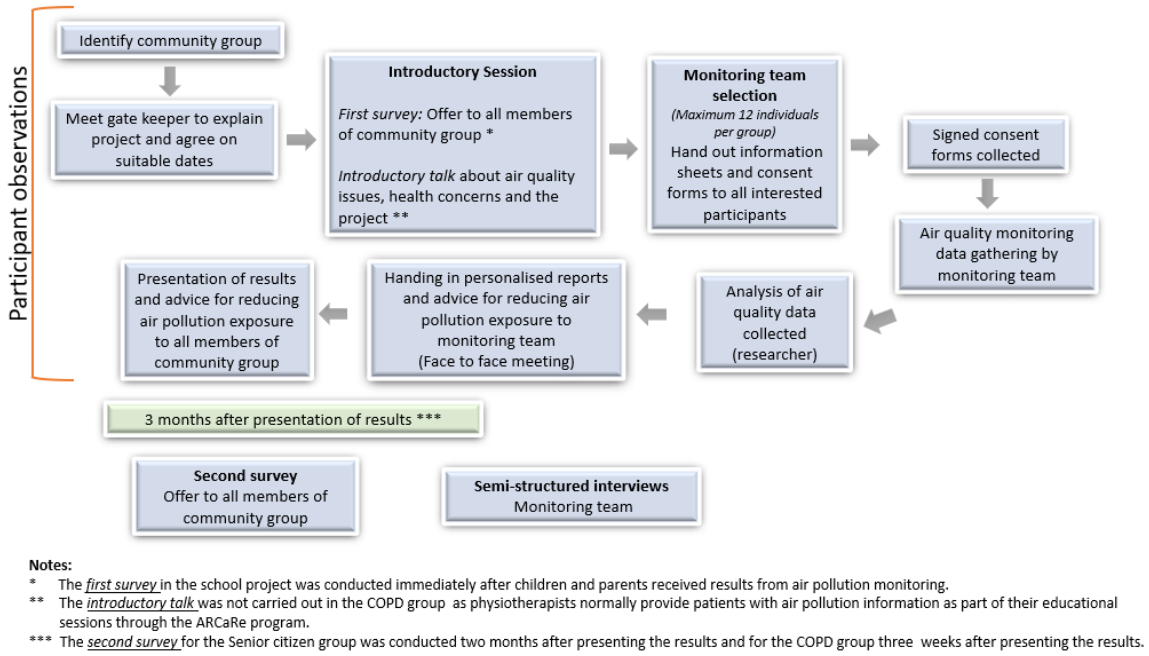


Figure 4-2 Study Design

4.1.3 Obtaining approval to conduct the studies

Prior to starting data collection, ethical approval was obtained from the King's College London (KCL) Biomedical Sciences, Dentistry, Medicine and Natural and Mathematical Sciences Research Ethics Subcommittee (BDM RESC) for four of the five case studies.

- Primary School ethical approval obtained on the 25 February 2015, Ref number: BDM/14/15-39.
- Parent and baby group ethical approval obtained on the 17 August 2015, Reference number: LRS14/151280
- Senior citizens group, ethical approval obtained on the 18 January 2016, Reference number LRS15/162313
- Breathe London projects, ethical approval obtained on the 10 June 2016, Reference number LRS-15/16-3268

The project with the Chronic Obstructive Pulmonary Disease (COPD) group involved working with NHS staff and patients. Therefore, in order to carry out the project, it was necessary to apply for NHS Ethical approval. The ethical approval for this project was granted by The Proportionate Review Sub-committee of the London - Brent Research Ethics Committee on the 21 September 2015, REC reference number 15/LO/1691. The Management permission "R&D approval" was obtained from the host organisation prior to the start of the study. The R&D approval was granted by the Research Management Office for Bart's Health NHS Trust and Queen Mary University on the 26 January 2016, ReDA reference number 010944. Ethical approval letters are presented in Appendix A.

4.1.4 Identifying the community groups

A purposive sampling strategy was used in order to identify groups where appropriate and useful data could be gathered. The following inclusion criteria were used to select the four groups:

1. Groups for which the study could have relatively high impact, that is, groups that could benefit the most by gathering knowledge about air pollution and reduction exposure measures. Children, older people, and people with chronic health problems are groups of people most at risk of air pollution (Holgate et al., 2016).
2. Groups of people where the dissemination of information was likely to be high. That is, groups whose internal organisation meant that participants could potentially share the information obtained with other members of the group.
3. Given the labour intensive nature of the projects carried out at each community groups, the specific sites were also chosen taken into consideration time and budget constraints. Therefore, community groups required to comply with criteria one and two above, while still being located within easy reach.

Subgroups of people (between ten and twelve individuals) from each of the four community groups identified were recruited to carry out the air pollution monitoring. The sample size of these subgroups was subject to the availability of pollution monitoring equipment. At the time of conducting these studies the Environmental Research Group (ERG) (host research group) had eight monitoring devices available. Therefore, the air pollution monitoring took place in groups of three and four participants at time, so I always had monitors available to give to participants as replacement in case of instrument failure.

The subgroups' inclusion criteria were:

- Individuals who attend the community group on regular basis and who could give informed consent. Throughout this thesis these subgroups will be referred to as 'the monitoring teams'.

- Individuals whose spoken language was either English or Spanish.

4.1.5 Approaching the groups and negotiating access

Gatekeepers are the supporters or individuals that provide access to the group, they can be formal gatekeepers, whose permission is needed for fieldwork to commence, or informal gatekeepers whose fieldwork support is crucial for the development of the project (Green, 2009, O'Reilly and Bone, 2010). In order to gain access to each of the community groups during this study it was necessary to contact a "gatekeeper". The active and participatory nature of this study meant that the gatekeepers I needed to engage with were both formal and informal. Three of the groups selected for this study were identified and approached with the help of third-party partners (primary school, senior citizens and COPD). The parent and baby group was identified and approached directly by me using a 'cold calling' approach.

The school was identified and recruited with the help of the local council environmental health officer who was known to me. The environmental health officer arranged an initial meeting with the school Deputy Head, who has been given the pseudonym of "Mrs Muller" throughout this thesis and who acted as a gatekeeper. The first meeting with Mrs Muller was my opportunity to persuade her to allow permission for the school to take part in this project. Therefore, I had to present the background and rationale of the project in an engaging and effective way. I highlighted the current air pollution issues around the area and explained why children are particularly vulnerable to air pollution (World Health Organization, 2005a). I then explained how the project could help raise air pollution awareness across the school that could then translate into health benefits for the children. I also mentioned that the project aimed to get the children and school community involved at all stages and that the practical side of the project (collecting the air pollution data) could potentially be linked to some of the activities planned in their own science curriculum. Favourably, the project's background and rationale explained to Mrs Muller was in line with her interest and desire to promote environmental activities in the school. After this meeting, Mrs Muller granted access to the school and became an active stakeholder throughout the project.

Similarly, the senior citizen group, which is a group from the University of the Third Age (U3A), was recruited with the help of a Research Associate in Engagement at KCL. During the first meeting with the senior citizen group leader, who has been given the pseudonym of Mr Woods, the aims and stages of the project were explained, and a time-table was put in place.

The Chronic Obstructive Pulmonary Disease (COPD) group was recruited through an environmental Non-Governmental Organization (NGO) known to me and my first supervisor. The NGO introduced me to the head of the Bart's Adult Respiratory Care and Rehabilitation Team (ARCaRe) by email and, from then on, I was in direct contact with the respiratory physiotherapists who run the ARCaRe group. This group provided care, support and rehabilitation exercise and education for patients with respiratory problems living in Tower Hamlets. During this project, patients from five different rehabilitation groups were contacted (each group had on average seven patients). A description of how this group was organised is presented in Chapter 5. An initial meeting was held with the head physiotherapist prior to starting the project because his support was needed to obtain the relevant ethics and R & D approvals. Once the approvals were in place the head physiotherapist put me in contact with the lead physiotherapist of the ARCaRe group, who has been given the pseudonym of Mr Rizzo and who was my main point of contact throughout the project.

Rather than relying on collaborators, the parent and baby group was identified and approached by me using a "cold calling" technique, that is to say, without an appointment or mediators. Three parent and baby groups located near King's College University campus were identified and contacted by email. Around the same time, we (Environmental Research Group) were launching the www.breathelondon.org website. In order to advertise the website launch, an ITV reporter was preparing a report about air pollution, which included filming members of the public measuring the air pollution levels they were being exposed to in their local area. In order to identify individuals to be part of the news report, I decided to visit the parent and baby groups I had already identified but I was still waiting to hear from. The main objective of this visit was to meet the gatekeepers to talk about the website, the website launch and their possible participation in the upcoming news report**.**

The first group that I approached, and which became one of my study groups was a parent and baby group which offers indoor soft play sessions for children up to the age of five-years-old in a large sports hall for two hours three times a week. The day I visited this group, the group committee, made up of three parent representatives, was holding their monthly meeting, therefore, I had the opportunity to speak to them directly. I introduced myself and my area of research, highlighting the air pollution issues we were currently facing in the local area and I told them about our new website launch. I asked them if they would like to be part of the news report and invited them to attend the website launch event to find out more. The group committee agreed to take part in the news report and they were also very keen to attend the website launch. See report at https://www.youtube.com/watch?v=Oi0gYt7Lj0Y. The committee then asked if there was the possibility of carrying the air pollution monitors for several hours or maybe days, so they could have a better indication of the air pollution they

were exposed to as they went about their normal days. This was an opportunity for me to introduce my project and to mention that I was looking for a community group (parent and baby group) to take part in this study. The main reason why these parents wanted to undertake the air pollution monitoring was because recent major developments in the area had considerably increased the vehicular flow along the local main roads. This, as they expressed "Is affecting the quality of the air we breathe and it is going to get worse!" One parent said that perhaps they could use the air pollution monitoring evidence gathered to show the local council and the developers how the air pollution was affecting local residents. Another parent was particularly anxious about the air pollution problem in the area due to the recent developments. She said that the area was changing rapidly and that she felt that there was nothing she or the local community could do to hide from these vast developments and their detrimental impacts. She also said that the members of the parent and baby group were very lucky that I was giving them the opportunity to learn more about air pollution and to conduct personal air pollution monitoring. I explained to the committee that the project aimed to recruit a maximum of 12 individuals from the group itself. Therefore, the invitation to take part in the monitoring exercise was open to all parent and baby group members. I also highlighted that information about air pollution causes and effects, the results of the monitoring exercise and advice as to how individuals can reduce their own air pollution exposure would be given to all members of the group, not just to the monitoring team. The committee agreed for the project to be undertaken so we arranged for a meeting at a later date with one of the chairs to discuss the project practicalities**.** My main point of contact during the project was one of the committee members, who has been given the pseudonym of Mrs Roberts throughout this thesis. With Mrs Roberts' support, a time table that took into account the group's activity schedule was organised.

4.1.6 Informing about the project, recruitment and consent

At the primary school, following the initial meeting, with the help of Mrs Muller, an assembly was held with pupils from year 2 to year 6 (approximately 400 children). This assembly (introductory session) had several purposes a) to give information to children about air pollution causes and effects b) to describe how the project would take place in the school and c) to explain how they could be part of it. This session was carefully designed taking into consideration Mrs Muller's recommendations in regard to the children's ages and level of scientific literacy. Following the introductory session, I held a short meeting with twelve children (monitoring team) who had been previously selected by Mrs Muller. During this meeting, the children were given specially designed project information sheets to read and had the opportunity to ask questions. Children were also given project information sheets for their

parents, and a consent form, which needed to be signed by their parents and returned to school. Ten consent forms were signed by the parents and sent back to school.

At the parent and baby group, Mrs Roberts recommended having flyers advertising the introductory talk and the air pollution monitoring, and asked for the flyers to be delivered at least two weeks prior to the introductory talk. Figure 4-3 shows the flyers that were distributed to members of the P&BG.

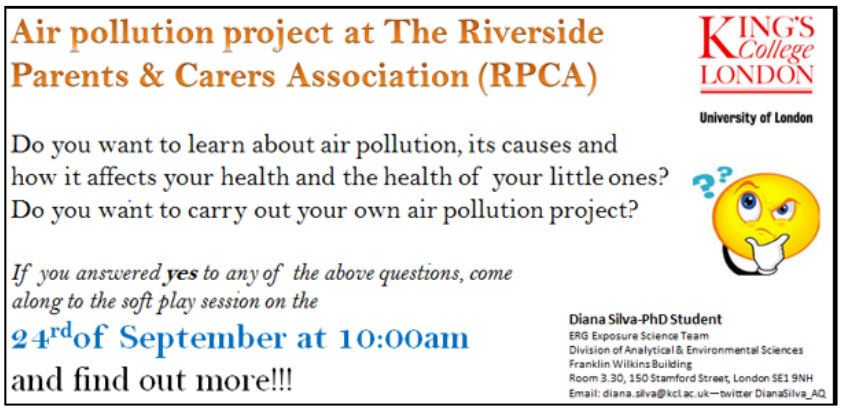


Figure 4-3 Advertisement flyer

The project was also advertised by Mrs Roberts on the group's Facebook page. As suggested by Mrs Roberts, the introductory talk took place on the date that most of the parents attended the group. On this day, the group attendance was 70 parents/guardians and 96 children. The hall was very big and there was no microphone. Therefore, talking to the parents was very difficult. About 42 parents/guardians moved closer to listen when I started talking, the rest of the parents/guardians present didn't get closer and continued looking after their small children while they were playing with the soft play equipment. I had prepared a fifteen-minute talk using flash cards and prompts. This talk included information about air pollution's causes and effects, an explanation about the project and information about taking part. The talk had to be cut in half as it was hard for the parents to hear and for me to convey the information. Some people did not seem to want to listen, others just could not listen as they were very busy with their children. Fortunately, I had also prepared posters which contained the information from the talk. I displayed these posters across the hall, so people could read them in their own time while the children were playing (Figure 4-4).

Figure 4-4 Poster displayed at the P&BG

Information sheets and consent forms were given to all interested attendees. By the end of the session, seven parents expressed an interest in taking part in the project and they agreed to meet at a later date where they would bring the signed consent form and pick up the air pollution monitor. Other parents said that they would read the information sheet at home and that they would email me to let me know whether they wished to take part in the project so we could agree on a suitable date. Later in the week, I received emails of interest from another four individuals. Mrs Roberts also asked me if she could take part in the monitoring. This brought the final number of participants to twelve.

At the senior citizen group, the introductory talk was advertised in advance by Mr Woods through the group's newsletter. The presentation lasted about forty minutes with fifteen minutes for questions. The points discussed during the talk included: air pollution causes and effects, the current air pollution crisis in London and an invitation to take part in the projects. One hundred and sixty-six people were present at the introductory talk, who seemed in general, very enthusiastic about the project, thus making particularly easy to recruit the monitoring team (twelve participants). Most of the volunteers were women, which was not unexpected as 70% of this UA3 group members are women. Information sheets and consent forms were given to all individuals interested in taking part in the project. Suitable dates/times for collecting the signed consent forms and the air pollution monitors were agreed with each of the participants. Mr Woods published a summary of the introductory talk in the group's monthly newsletter the following month (Appendix B).

The information session at COPD group was organised by Mr Rizzo who arranged a meeting with the physiotherapists in charge of each of the five ARCaRe subgroups. During this meeting, I had the opportunity to explain the aims and objectives of the project as well as some of the practicalities involved. This meeting was very productive as I learned in detail how the

sessions were conducted by the physiotherapists. This meeting also gave the physiotherapists the opportunity to have their own input in the design of the project. For example, the physiotherapists highlighted that there was no need to carry out an introductory talk because they normally provide patients with air pollution information as part of their educational sessions through the ARCaRe program. Instead, they noted, that they would like to use the results obtained from the monitoring exercises as evidence to support their air pollution education session. Physiotherapists also recommended that the monitors were given to participants for at least one week as many of them struggle to go out for several days at a time due to their condition. Physiotherapists expected that, by so doing, participants could have a better opportunity to record outdoor air pollution monitoring data. At the COPD group the monitoring team was selected by the physiotherapists, who agreed to inform each of the five rehabilitation groups about the project and recruited two to three participants per group to be part of the monitoring team. The physiotherapists decided to choose participants whom they thought could benefit most from collecting the air pollution monitoring data. Such participants included people who despite their condition were trying to keep active mostly outdoors. The physiotherapists gave participants the information sheets and the consent forms to be signed and returned if they wished to take part in the project. Two weeks later, I was contacted by Mr Rizzo who gave me a list with the names of twelve individuals who had agreed to take part in the project and who had returned the signed consent form.

4.1.7 Air pollution monitoring

The instruments

The air pollution monitor used during each of these projects was a portable (280 g), black carbon aerosol monitor (Micro-aethalometer model AE51, Aethlabs, California, USA). This instrument continuously logs BC concentrations by measuring changes in absorption of transmitted light at 880 nm with collection of light-absorbing BC particles deposited on a small Teflon-coated borosilicate glass fibre filter. The Micro-aethalometer has been used extensively across the world for air pollution exposure studies and has demonstrated robust performance against full size reference “gold-standard” instruments (Viana et al., 2015, Cai et al., 2014).

For the primary school project the monitor’s averaging time was set at 30 seconds, for the other studies (parent and baby, senior citizens and COPD) the averaging time was set at 60 seconds. The instruments’ pump flow rate was set at 100 ml/min for all projects. The operational settings used during these studies are based on the recommended manufacturers settings for personal exposure monitoring (AethLabs, 2015). Black Carbon (BC) is one of the components of fine particulate matter ($PM_{2.5}$) and a strong indicator of diesel vehicle emissions (Buonanno et al., 2013, Invernizzi et al., 2011), which has been classified by the

World Health Organisation (WHO) as a class 1 carcinogen (World Health Organization, 2012c) and represents a component of air pollution thought to have amongst the greatest potential risk to public health.

The air pollution monitor was coupled with a Global Positioning System (GPS) watch (Foretrex 301 model - Garmin, USA), which recorded the participants' whereabouts at the time when the air pollution measurements were taking place. All devices were subject to extensive performance checks before being handed out to participants and after the data were collected. The instruments were operated in line with manufacturer's guidelines and best practice procedures. BC measurements were downloaded immediately after each sampling session to minimise date handling errors.

Training to take the air pollution measurements

Before starting the air pollution measurements, all participants received instructions on turning the monitor on and off and on using the charger provided. They were also advised to make sure that the tube connected to the monitor at one end was placed near their breathing zone at the other end at all times. This advice was given in order to measure the black carbon present in the air inhaled by the participants. Participants were also shown how to turn the GPS watch on and off and how to recognise if the watch was running out of battery. One spare pair of batteries was provided to all participants.

As well as the monitors and GPS watches, participants from the parent and baby group, senior citizen group and COPD group also received an activity diary sheet to fill in. The purpose of this activity diary was to gather more detailed information concerning the places visited and activities carried out by the participants, so a more accurate feedback report could be prepared (Appendix C provides an example of a completed activity diary). The primary school children and their parents didn't fill in the activity diary as they were only measuring the air pollution they were exposed to during their trip to and from school. Figure 4-4 shows one of the Micro-aethalometers and GPS watches used.

Figure 4-4 Micro-aethalometer and GPS

The air pollution measurements

At the primary school, ten children from Years 2 to 6 (between 7 and 11 years of age) took part in the monitoring phase of the project. The air pollution measurements took place over five days. On each of these days, two children accompanied by an adult (parent/guardian) carried an air pollution monitor and a GPS watch as they travelled back home from school. Half of the children also carried the monitor the next day as they travelled to school in the morning. Some children and their parents decided to walk the same route they walked every day, while others decided to take a different route for part of their journey. This project received media attention (https://www.youtube.com/watch?v=QDNuT87StW0)

The air pollution monitoring at the parent and baby group took place over two weeks and each participant carried the monitor for over 24 hours. I met briefly with each of the participants when they picked up the monitors. During these meetings I collected the consent forms from each of the participants. I explained how to use the BC monitor and GPS watch, as well as how to fill in the activity diary. Participants used the monitors to measure the levels of air pollution they and their children were exposed to as they went about their daily routine. Most of the participants placed the inlet tube of the monitor near the children's breathing zone or on the pushchair. I met again with each of the participants to collect the equipment and during this encounter we arranged a suitable day/time to meet again to receive the results.

The measurements at the senior citizen group took place over two weeks. Each participant had the opportunity to carry the monitor for 48 hours. Most of the participants carried the monitors as they went about their daily routine, while others used the monitors to find out how the air

quality was in areas of particular concern. This project also received media attention (https://www.youtube.com/watch?v=6f33z5PtEow).

The air pollution measurements at the COPD group were conducted taking into account the physiotherapist's suggestions. As requested by the physiotherapist, I arrived at each of the ARCaRe groups at the end of their session. I met with the individuals recruited by the physiotherapists, collected signed consent forms and handed out the air pollution monitors, GPS watches and activity diaries. Each of the participants carried the monitor for one week as they went about their normal activities.

Air pollution data results reports and feedback

The participants from each of the groups that carried out the air pollution monitoring (the monitoring teams) received individual reports of the data they collected. The air quality data recorded while the participants were in motion (walking, cycling, or in a vehicle) was presented to the participants using graphs, tables and maps, Appendix D shows an example of the reports each of the participants received. Given that BC is a pollutant for which neither a safe level nor a toxic threshold has been identified yet, I presented the project findings to participants, using relative comparisons in the context of what we could do to reduce their exposure to air pollution based on precautionary principles. For example, low concentrations (highlighted in blue) measured on the back streets against high concentrations (highlighted in red) normally measured on the main roads and junctions. Taking into account the participants feedback, I also presented in the reports, the average BC exposure for each of the activities reported by all participants (e.g. walking, bus, at home etc). As a result, some participants based their interpretations of the findings on comparisons between their measurements and those of others.

The maps were produced using the Real-time Geospatial Data Viewer (RETIGO) which is an Environmental Protection Agency (EPA) developed web-based tool (https://www.epa.gov/hesc/real-time-geospatial-data-viewer-retigo). These reports were given to participants face to face. Meetings with each participant lasted ten minutes on average. During these meetings, I explained the information contained in each of the graphs and maps given to the participants, who then had the opportunity to ask questions and, or discuss their findings. Together with the results report, participants received a leaflet with advice and information about the things they could do themselves to reduce their exposure to air pollution (Appendix E). During these meetings, participants were also asked if they would like to share their monitoring findings with the rest of their community, and if so, what they thought would be the best way for communicating these findings to the rest of their community groups.

Dissemination of results back to community groups

At the end of each of the air pollution monitoring projects, the monitoring data gathered were presented to the rest of the community group members. In line with the participatory nature of this study, participants were encouraged to disseminate their findings, however, the dissemination process from each of the participants in the majority of the groups, was rather passive, mostly limited to their inner circle of family and friends. Although, participants were happy to share their findings, many of them did not want to take and active role at doing so, and they preferred for me to share their findings with the rest of their community group.

At the primary school, children shared their findings to the rest of the school during an assembly using a PowerPoint presentation. At the parent and baby group, the results were presented over two days during the scheduled group sessions using poster displays and leaflets. At the senior citizen group, the presentation of the results took the form of a formal PowerPoint presentation prepared and steered by me, while at the COPD group, as planned with the physiotherapists, the results were presented to each of the rehabilitation groups by the physiotherapist with my support as part of their air pollution session. The information (results) disseminated at each of the groups were taken from the reports given to each of the participants. Gatekeepers were also involved in the decisions of how to disseminate the findings within each group as they (the gatekeepers) ultimately had control over the activities conducted in each group.

4.1.8 Surveys

Survey is the term used for the systematic collection of the same set of information from the population of interest (Green, 2009, Hammond, 2013). Surveys normally gather data about measurable variables, in the case of this study, information about age, ethnicity, gender, and rating scale responses about air pollution knowledge and awareness etc. Surveys can also contain open-ended questions that aim to capture data about participants' views on a particular topic (e.g. do you think that air pollution affects people's health, in what ways? etc.)

The purpose of the surveys conducted during this study was not to provide statistical associations between variables but rather complement the other data collections methods (observations, semi structured interviews) in order to aid with the contextualisation of the participant's narratives.

The economical, less time consuming and anonymous nature of surveys make them an efficient tool for gathering information from large populations. By using surveys during this study, I was able to gather information from many members of the community groups about a) participants' level of air pollution awareness prior to the air pollution project and b) information about how the air pollution monitoring findings impacted the surveyed participant's air pollution views and perceptions. Although the purpose of the surveys was the

same in the four community groups studied, the diverse nature and agendas of these groups meant that the surveys had to be administrated in different ways. The anonymous nature of the surveys, meant that it was not possible to track repeated responses (pre and post) from those participants that took part in the surveys. The following section will briefly describe how the surveys took place at each of the community groups.

At the primary school all 400 children and their parents were invited to take part in two short surveys. The first survey aimed to capture the children's and parents' initial response towards the personalised air quality data gathered and the advice and information received. The second survey, conducted three months after the results were presented, aimed to assess: a) whether participants' initial response towards the results had changed over time, b) if participants adopted new routines in order to reduce their air pollution exposure and c) whether they disseminated the information they received to other members of their family and community. The questionnaires were piloted before being used for the study with a small group of children of similar age and with parents, who were not part of the study. Both surveys were distributed to the children by the class teachers. The parent surveys were put in the children's school bags to take home.

At the parent and baby group, the first survey was conducted just before the introductory talk took place and the second survey was conducted three months after the results were presented. The second survey was offered to all parents attending the baby group over a week (Three parent and baby group sessions) and it was distributed and collected by the group's helpers.

At the senior citizen group, the first survey was conducted before the introductory talk and was offered to all 166 attendees. The second survey was conducted at the beginning of a scheduled U3A meeting two months after presenting the results and it was offered to all 132 attendees.

At the COPD group, the first survey was given to all individuals attending the five ARCaRe groups. There were about eight people on average at each ARCaRe group when the surveys took place. These surveys were handed out and collected by the physiotherapists in charge of each of the groups during a normal session before the monitoring exercise. The second survey was also offered to all individuals attending the ARCaRe groups and it was administered by the physiotherapists. The second survey was conducted three weeks after the results were presented at each of the groups.

The questionnaires used with the parent and baby, senior citizens and COPD groups were piloted before being used with a small group of adults who were not part of these studies. The questionnaires used are presented in Appendix F.

4.1.9 Interviews

Semi-structured interviews were used during this study to supplement the other data collection methods (participant observation and surveys). Two types of interviews were conducted – informal and formal (Grbich, 1999). The informal interviews took place throughout the development of the studies, and took the shape of 'informal conversations' where participants would approach me to ask questions or share their thoughts and views on the subject of air pollution. Like the participant observations, the details from these informal conversations were written up from memory after the events took place.

Formal semi-structured interviews on the other hand, were planned in advance, participants were informed at the beginning of the study that an interview was part of the air pollution monitoring project, and they were asked to sign a consent form. Interviewees were selected as per the inclusion criteria presented in Section 4.1.4 of this chapter. When the participants received the air pollution monitoring results they were reminded of the interview, and a convenient date and place was agreed. One week before the interview, an email or an SMS text message was sent to participants to remind them about the interview and to confirm the date and place. The active nature of my role during the studies meant that I had already a relationship with most of the interviewees.

During formal interviews, the researcher determines topics to be discussed. However, the information provided about each of the topics is determined by the interviewee (Green, 2009). The semi-structured interviews conducted in this study aimed to capture participants' experiences of participation in the air pollution monitoring project as well as the participants' views and perceptions towards air quality issues. An interview topic guide was developed and served as broad guidance (Appendix G). This topic guide included areas such as: a) motivation for taking part b) responses to the data, c) impact on participants' behaviour and d) dissemination of project findings with family, friends and community. Although, the topic guide for the interviews was prepared beforehand sometimes, during the interviews, the order of the questions and the way the questions were worded was changed in order to make the interview conversational and/or clearer.

All interviews were recorded using two audio recording devices in order to minimise data loss due to equipment failure. I transcribed the interviews from the primary school participants, all others were transcribed professionally.

4.1.10 Triangulation - Use of other data sources

Triangulation is broadly defined by Denzin 2009, as "the use of multiple methods in the study of the same object" (Denzin, 2009). The triangulation metaphor is borrowed from military and navigation strategy, where multiple reference points are used to pin down the exact location of the object of interest. In a similar way, by combining multiple data sources researchers can improve the accuracy of their judgment and overcome the intrinsic bias that comes from single-data sources (Denzin, 2009, Jick, 1979). Denzin, also argues that triangulation does not necessarily only refer to improved "accuracy" but it also refers to improved understanding (Denzin, 2009).

At the onset of this PhD, the original strategy was to carry out five community-based air pollution monitoring projects, however, during the second year of my PhD and after some reflection, I realised that until then, my sources of data were solely from lay members of the public, who I had personally engaged and encouraged to take part in this study. Therefore, I decided to seek other sources of data from which I could obtain information about the perceptions and attitudes towards air quality issues but this time from individuals that carried out similar air pollution monitoring exercises on their own accord.

The following section describes the origins of the additional data sources used, as well as the methods employed for collecting this data.

Breathe London Project

The "Breath London Project" (BLP) was founded in 2014 by the Biomedical Research Centre at Guys & St Thomas NHS Foundation Trust & King's College London under the supervision of Dr Ben Barratt from the Environmental Research Group (ERG) at King's College London. The project's main objective was to provide community groups with access to scientific expertise and equipment to carry out their own air pollution monitoring projects. Communities could propose their own projects via the website (http://www.breathelondon.org), a number of which were supported each year. As a member of the ERG, I was responsible for managing the Breathelondon website and, together with my first supervisor, we provided the technical advice required by these community groups. I, therefore, had the opportunity to meet most of the project coordinators. Between 2014 and 2016 twelve projects were carried out by different community groups and we directly provided these groups with technical support and advice to conduct these projects.

The Breathe London Project provided me with an remarkable opportunity for gathering data from different perspectives that could help me answer my research question. By engaging with these groups, I was able to gather information about the underlying reasons for proposing these projects, the overall experience of carrying out the data collection and the impact that this data has had on participants' views and perceptions of air quality.

The process for engaging with this group was less onerous compared to the community groups. I contacted individuals from nine Breathe London Projects (BLPs). I explained the purpose of my project and asked if I could interview them. Potential participants were also sent information sheets and consent forms to be signed and returned if they decided to be interviewed. Detailed information for each of the Breathe London projects from which I contacted individuals can be found at www.breathelondon.org. In the following Chapter, in section 5.2, I provide a summary of the Breathe London projects and a description of those individuals from each BLP project, who agreed to share their experiences me.

4.2 Data Analysis

In ethnography, the analysis of the data stage is a continuous process that begins even before the study commences (Hammersley, 2007). The researcher's ideas for the study design and collection of data can be shaped by the information gathered by informally analysing data that is linked to the research study (e.g. conferences, lectures, documentaries, news reports) (Hammersley, 2007). The aim of a researcher during the formal data analysis stage is to tell the story of the research participants while attempting to provide a broader meaning of the findings (Green, 2009).

Consistent with the epistemological position of this study, an inductive and iterative analytical procedure was adopted when analysing the data collected during this study. Using a thematic content analysis approach the data were analysed to identify recurrent or common 'themes' (Green, 2009). Tentative themes were identified during informal preliminary analysis of the data during and after collection. These ideas were noted and formed the basis of formal data analysis which took place after all fieldwork was completed (November 2016).

Throughout my data analysis I followed Creswell's (2013) data analysis spiral approach which emphasises the idea that to analyse qualitative data, the researcher engages into a spiral analytical process right through to the final writing of the report rather than following a linear analytical approach (Creswell, 2013). This approach encompassed five main steps as follows:

- *Organising the data:* The NVivo software (Version 11) (Bazeley and Jackson, 2013) was used to assist with the management and handling of the data. This software allowed me to cut and paste extracts of my data transcripts between documents, codes and themes. Field notes from participant observations which have been previously transcribed from draft notes and all of the digitally recorded transcripts from the interviews were imported to NVivo. The data collected from the surveys was organised using excel where the multiple choice questions were tabulated, while the qualitative data was also imported to NVivo.

- *Reading and writing:* Audio recordings were listened to multiple times in order to familiarise myself with the data. Print outs of the data were read several times and sketch notes highlighting initial ideas and key themes were recorded.
- *Describing, classifying and interpreting data into codes and themes:* Field notes and interviews were analysed inductively, locating text segments and assigning a code to label them. These codes were then organised by identifying recurrent or common themes in order to identify key elements of the respondents accounts. At this point during the data analysis, a meeting was held with my second supervisor in order to compare notes and preliminary codes identified. This was done in order to agree on the evidence, the reasoning behind the chosen codes and to note any gaps in the data (Grbich, 1999). The next step during the data analysis was to assess how the identified codes were related to each other in order to combine them into broader categories. General themes were then identified during my supervisory meetings, and discussed with advisors at my PhD thesis committee meetings. Final themes were reviewed and finalised during the final writing of the thesis.
- *Interpreting the data*: Final themes became the results chapters and these findings were linked and contextualised to different bodies of literature throughout the results chapters and in the discussion chapter.
- *Representing and visualising the data:* visual interpretations of the analysed data were produced in order to provide the reader with a clear snapshot of the findings, these visual representations of the data are presented in later chapters.

Chapter 5 - Study settings and participants

Introduction

The field where this ethnography study took place differs from classical ethnography notions of the field, which have traditionally located groups of study in a physical site bounded and identifiable (Marcus, 1995). During this study, the participants that took part were active members of a range of community groups, indicating a variety of cultural and social groups of people which share common values or interests (Schiavo, 2013).

The purpose of this chapter is to set the scene for the study. The first part of this chapter provides an overview of each of the four community groups that took part in this study in regard to: a) ethical considerations, b) location and environmental conditions (air quality) and, c) structural organisation, access and engagement. In the interest of transparency and reflexivity, during this section, as well as providing descriptive details about each group, I will also provide my personal interpretation of how situations developed when approaching and engaging with community groups and participants. The second section of this chapter will provide information on the participants from each of the community groups that carried out the air pollution monitoring (the monitoring teams) and which were interviewed. The third section of this chapter will focus on providing details about other sources of data 'Breathe London Project' and on the individuals interviewed from this project. Finally, in order to contextualise the participants' narratives that will be presented in the following chapters, the final part of this chapter will provide an overview of the heightened media interest in air quality during the period of fieldwork.

5.1 Overview of the community groups

While air pollution potentially harmful to everyone as highlighted in Chapter 2, there are certain groups in society such as children, older people and those individuals with pre-existing cardiovascular and respiratory diseases who are particularly vulnerable to the harmful effects of air pollution (Holgate et al., 2016, Gehring et al., 2013, Kim, 2004). It has been suggested that lower socio-economic households are more likely to live in areas which are particularly affected by poor air quality (Wheeler and Ben-Shlomo, 2005, Defra, 2006). However, the link between deprivation and poor air quality is more marked in outer London. In inner London everyone is potentially exposed to air pollution, wealthy and deprived communities alike.

The majority of the data collected for this PhD thesis come from over two years of fieldwork undertaken with four community groups across London, Figure 5-1. Approximately 50 hours of fieldwork (participant observation) were carried out.

The study aimed to engage with community groups for which participation in the study could have a bigger impact, that is, groups of individuals who are particularly vulnerable to air pollution (children, the elderly and people with respiratory diseases).

Figure 5-1 Community groups

Drawing on a participatory research approach, members of these community groups took part in an education session about air pollution causes and effects. A subset of participants from each of these groups measured the air pollution they were exposed to as they went about their daily lives using portable exposure monitors and GPS watches, and shared the data they collected with the rest of their community groups.

5.1.1 Anonymity

Throughout this thesis pseudonyms are used to protect the identity of the community groups and the research participants. To reduce the risk of participant identification, the information provided about participants is restricted to the minimum considered relevant for the contextualization of the findings. The pseudonyms given to interviewees are accompanied by a letter ID. This letter ID was used to link each of the participants to their personal air pollution exposure data. First contact with community group gatekeepers was formal, through emails or pre-arranged meetings; therefore, from the beginning of the projects gatekeepers were given titles together with their surnames (e.g. Mrs Muller - school deputy head). All other participants introduced themselves by the first name, therefore, I have given them alternative first names. (Full details of the ethical approval process are presented in Chapter 4 Methods, Section 4.1.3 ‘Obtaining approval to conduct the studies’). Detailed background of each of these community groups, their environmental, geographical and cultural setting is provided in the following sections.

5.1.2 Community groups' location, air quality and vulnerability

The community groups that participated in this research were located in a number of London boroughs across the city. Two of these groups (primary school and parent and baby group) were located in southeast London boroughs (Lambeth and Southwark), areas with particularly poor air quality. At the time of conducting these studies, Air Quality Management Areas (AQMAs) were in place across the whole of these boroughs as the current national air quality objectives (Defra , 2015) for Nitrogen Dioxide (NO_2) and Particulate Matter (PM_{10}) were not being met. In 2014, Public Health England (PHE) estimated that approximately 7.7% and 7.9% of adult deaths in Southwark and Lambeth respectively, may be attributable to particulate air pollution measured as $PM_{2.5}$ (Gowers et al., 2014).

In this area, as for most of London, the emission sources for these pollutants are dominated by road transport (Lambeth Council, 2014). Main roads around these areas are particularly congested especially during rush hours as seen in Figure 5-2 below, a picture taken during the morning rush hour on my way to one of the parent and baby group sessions.

Figure 5-2 Parent and baby group neighbourhood's street

Children are particularly vulnerable to air pollution as they spend more time outdoors, have smaller lungs and higher ventilation rate. Air pollution can inhibit children lung development, and as a result increase their vulnerability to chronic diseases and respiratory exacerbations (World Health Organization, 2005a). A report commissioned by the FIA Foundation in 2017 revealed that one in five of London's state primary schools and secondary schools were in areas with poor air quality in 2013 (Brook et al., 2017). Similarly, a report by Green Peace in 2017 found that more than 750 nurseries in London alone are located near an illegally polluted road. Figure 5-3 overleaf, shows a street commonly transited by the children and parents in this study.

Figure 5-3 Primary school neighbourhood's street

The child in the picture above was one of the participants He normally travelled to school by bicycle. For most of his journey he had to ride his bicycle on the pavement as there were no designated cycle lanes in place.

The senior citizen group was located in the London Borough of Bromley 12 miles from central London, which benefits from a mixture of rural space, with large areas of protected countryside in the south, and suburban development in the north. Despite its rural aspect, Bromley also has areas with high volumes of traffic, particularly during rush hours (Figure 5-4 below). An AQMA was declared in 2007 in the northwest corner of the borough due to exceedances of the nitrogen dioxide annual mean Air Quality Objective (AQO).

Figure 5-4 Picture of senior citizens group neighbourhood

While the long term impacts of air pollution in the elderly are not well documented, there is sufficient evidence of the adverse effects related to short term exposure (Simoni et al., 2015). Increased air pollution exposures in the elderly have been associated with an increased mortality and hospital admissions mainly due to exacerbation of pre-existing conditions or to respiratory tract infections (Simoni et al., 2015). In 2014 Public Health England (PHE)

suggested that approximately 6.3% of adult deaths in Bromley may be attributable to particulate air pollution measured as $PM_{2.5}$ (Gowers et al., 2014).

The Chronic Obstructive Pulmonary Disease (COPD) patient group that took part in this project was part of the NHS Adult Respiratory Care & Rehabilitation (ARCaRe) service in the London Borough of Tower Hamlets located in East London. The whole of the borough has been designated as an AQMA for NO_2 and PM_{10} (London Borough of Tower Hamlets, 2017). Although, the Borough includes headquarters of many global financial businesses, some areas in the borough have the highest level of child poverty in England, very high rates of long term illness and premature death and the second highest unemployment rate in London (London Borough of Tower Hamlets, 2018). Figure 5-5 shows an area typically transited by some of the COPD patients.

Figure 5-5 COPD group neighbourhood

Patients with COPD are a particularly high risk group. Outdoor air pollution can exacerbate COPD symptoms and increase respiratory infections which can result in dangerous COPD attacks (Holgate et al., 2016). COPD can also result in increased breathlessness which can affect the ability to carry out daily activities and tasks to a point where individuals living with COPD can become housebound. The World Health Organisation has listed COPD as the fourth largest cause of mortality globally, responsible for 3.2 million deaths in 2015. The UK is among the top 20 countries for COPD mortality worldwide with an estimate of 30,000 deaths a year from COPD (World Health Organisation, 2017). Approximately 3 million people currently suffer from COPD in the UK of which over 2 million remain undiagnosed (British Lung Fundation, 2016). According to 2011 estimates, there are over 6,400 people living with COPD in Tower Hamlets (Tower Hamlets, 2015). In 2014 Public Health England (PHE)

suggested that approximately 8.1% of adult deaths in Tower Hamlets may be attributable to particulate air pollution measured as $PM_{2.5}$ (Gowers et al., 2014).

5.1.3 Community groups' structural organisation, access and engagement

When approaching the groups, I always introduced myself as an air quality scientist. Community group leaders (gatekeepers) saw me as the 'expert' and that is how they introduced me to the community group members.

Primary School: This study took place during the spring term of 2015, during this time, 509 pupils between the ages of 3 and 11 years were attending the school. Approximately, 400 pupils from year 2 to year 6 (7 to 11 years old) were involved in one or more phases of the study. The ethnic backgrounds of the pupils attending this school included: Bangladeshi, Somali, African-Caribbean, Chinese, Portuguese and White British. The proportion who spoke English as an additional language was well above UK average and over half of the children attending the school received free school meals, an indicator of lower socio-economic status (SES). The school's admission criteria require children to live within its catchment area meaning that most of the pupils resided within walking distance to school.

The school deputy head, Mrs Muller, introduced me to the school children and teachers before the introductory talk at an assembly. She said, '*we have a special guest today that is going to talk about air pollution, she is coming from King's College London, which is a university not far from here, maybe one day you can all go there and be scientists too'*. At this point, I felt that my role in the school changed from a 'researcher', who was there to deliver a health message and to recruit children and parents for a project, to a 'role model' for the children, a person to look up to. After this rather unexpected introduction, every time I visited the school I was always surrounded by children, who were always very welcoming. Even when I was outside the school waiting for the school to open in the morning or in the afternoon on my way home, children would approach me trying to make conversations and some would even ask me questions about air pollution.

The school felt encouraged to participate in the project as they felt that this was an opportunity for promoting the adoption of environmental activities at the school, which in turn, could help raise the children's awareness and understanding of environmental issues. As Mrs Muller said "*I just think it is very good to educate children concerning, you know, environmental issues particularly when they live in central London which you know is very congested and particularly our area" (Mrs Muller).*

Parent and baby group: This group was founded in 2006 by a group of parents and carers who wanted to arrange regular soft play sessions for children up to the age of five years. This

group offers indoor soft play sessions in a large sports hall for two hours three times a week during term time only and relies upon funding and donations for its operation. The group is run by a volunteer committee made of three co-chairs, one of whom acted as "gatekeeper" during the project. Children attend these sessions accompanied by either one of the parents or grandparents, or by their childminder. This project took place during the second half of 2015, during this time, there were approximately 500 parents registered on the group, with an average of 70 parents/carers attending each of these soft play sessions. Parents/carers were from various ethnic backgrounds, predominantly white (British), and the majority lived within the borough.

When I first met with the parent and baby group gatekeepers, parents and carers were very concerned about their local environment as new developments in the area were taking place, changing the scenery of their neighbourhood and increasing the amount of traffic on the local roads. Despite common interest in the project, some of the parent and baby group committee members were initially reluctant to allow me to carry out the project. They expressed their disappointment of constantly having researchers or institutions that 'knocked at their door, asked group members to fill in surveys and then disappeared'. One of the committee members argued that researchers should be charged to access the group and that this money could then be used to support the group's expenses. Mrs Roberts, my main contact at the parent and baby group, was always very supportive of my project and hence she convinced the rest of the committee to take part by highlighting the benefits of taking part. She said to me "*we want to get something back and you are not just coming to get something from us, you are giving us the data"*. She said that the committee had agreed to this project given that the project was giving them the opportunity to gather their own air pollution exposure data. However, from then on, the committee put in place a policy where researchers or anyone interested in accessing the group for research or marketing purposes would need to send an official request highlighting how the group would benefit monetarily or otherwise from taking part.

Senior citizen group: This group was one of the many groups that the University of the Third Age (U3A) have across the UK. The UK University of the Third Age is part of an international organisation founded approximately 35 years ago to provide education for those "no longer in full time gainful employment". All U3A groups are operated by unpaid volunteers. The U3A group that took part in this study meets once a month for one hour where an invited speaker 'expert in their field' normally presents for 45 minutes followed by a question and answer session. The senior citizens project was carried out during the first three quarters of 2016. During this period the attendance recorded at each monthly meeting was of 150 people on average, mostly 60 years and older, with around 70% being women. The majority of individuals who attend this group were from a white (British) background. The members of

this group were particularly active. They spend most of their day away from home doing a variety of activities, including knitting clubs, salsa lessons, hiking, yoga and church groups.
Accessing and engaging with the senior citizen group was straightforward right from the start. Mr Woods, the gatekeeper, was very enthusiastic about the topic and so were the group members, who found the topic of air pollution interesting and important. I first met the senior citizen group when delivering the introductory talk, where people received information about air pollution causes and effects and were invited to take part in the project. Before, during and after the presentation, I had the opportunity to talk to many of the members of the group, who were asking questions and my opinion on a number of air pollution related issues. Group members also commented that they felt that my PhD research was very important as I was raising air pollution awareness among the general public.

COPD Patient Group: This group was part of the NHS Adult Respiratory Care & Rehabilitation (ARCaRe) service in the London Borough of Tower Hamlets. The ARCaRe programme provides an extensive cardiorespiratory rehabilitation programme that includes self-efficacy building for patients so that they can manage their life with their condition more effectively (Tower Hamlets, 2015). The program runs eight-week courses at different locations across Tower of Hamlets including, community halls, churches, medical centres and hospitals. COPD patients attend these courses twice a week for 1.5 to 2 hours. Each of the courses has a maximum of ten patients. These sessions are conducted by a respiratory rehabilitation physiotherapist and are normally divided into two parts. The first part involves a supervised and guided exercise session, where patients carry out gentle exercises to work on their fitness. The second session involves an education session where patients receive advice about self-management and learn about things that could worsen their condition (e.g. air pollution).
The individuals attending these groups were from a variety of ethnic backgrounds, but predominantly white (British). Some individuals did not speak English and hence, a translator provided by the NHS had to be present during their rehabilitation sessions.
The project with the COPD group was carried out during the first three quarters of 2016. During this time patients from five different rehabilitation groups were contacted. Each of these groups had on average seven patients from which two or three people from each group took part in the project. Over 50% of those attending these groups were older than 65, about 30% were between 55 and 64 years old, and there was no one younger than 35 years old. There were similar percentages between men and women.
This project involved working with NHS staff and patients, therefore, it was necessary to obtain NHS ethical approval, a process that took over 6 months. Once this was granted, I had to engage with three levels of 'gatekeepers'. The first gatekeeper was one of the 'Advanced Practitioners' from the ARCaRe program, who reviewed all my paper work (ethical approval

and study protocol). The Advanced Practitioner then directed me to the second gatekeeper, 'Mr Rizzo', the lead physiotherapist of the ARCaRe group and who was my main point of contact throughout the project. The third gatekeepers were the five physiotherapists in charge of each of the five ARCaRe subgroups, and who informed each of these groups about the project and recruited two to three participants per group to be part of the monitoring team (individuals that carry out the air pollution measurements). I first visited each of the rehabilitation groups (five different settings) when the physiotherapists were informing their members about the project. As with the previous community groups, the COPD group gatekeepers also introduced me to the members of the five rehabilitation groups as the 'air quality expert'. Many of the members of these groups had serious health issues, some were attending the rehabilitation sessions carrying oxygen tanks, while others had to use the oxygen tanks on arrival as their trip from the house to the rehabilitation centre was exhausting.

5.2 Interviews

Semi structured interviews were planned and carried out with the individuals from each of the community groups that carried out the air pollution monitoring. I interviewed 64 participants including children, mothers, fathers, grandparents, office workers, a Member of Parliament (MP), a journalist, environmentalist, cyclists, pensioners and individuals with COPD (Table 5-1). Interviewing such a wide range of people gave me the opportunity to document a wide variety of responses regarding participation in the air pollution monitoring project as well as the participants' views and perceptions towards air quality issues.

At the primary school, semi-structured interviews took place over one week, three months after the results feedback session. Interviews were planned with all children and parents that carried out the air pollution monitoring (n=20). However, Nathan had to travel unexpectedly with his family and Safa's parent did not attend the interview appointment. This brought the final number of interviews to nine children and eight parents. The semi-structured interviews with the children lasted between 8 and 10 minutes. The interviews with the parents lasted between 10 and 20 minutes. These were kept short as parents agreed to be interviewed only if the interview was short and they could do it after dropping off the children to school before going to work. Children and parents were interviewed separately. One of the parents requested to be interviewed over the phone. The deputy head, 'Mrs Muller', was interviewed on two occasions: The first time, immediately after the results were presented and the second time, three months after receiving the results. Mrs Muller's interviews lasted 15 minutes on average as she also requested for the interviews to be kept brief. All face-to-face interviews were conducted on the school premises.

Semi-structured interviews at the baby group took place over a period of two weeks, three months after the results feedback sessions. Interviews were planned with the parents/guardians that conducted the monitoring exercise (n=13), however, two participants did not attend the interview appointment. Hugo had a tragic loss in his family while the interviews were taking place and therefore decided not to go ahead with the interview. Roberta, who was a nanny, changed her job location: therefore, she declined to be interviewed. One of the participants (Martha) requested for the interview to be carried out in Spanish as she did not feel that she could communicate well in English. As I am a native Spanish speaker I was able to honour Martha's request. Interviews lasted twenty minutes on average and they were conducted at the baby group venue and at local cafes.

At the senior citizen group, the semi-structured interviews with the monitoring team (n=12) took place over 3 days. These interviews were carried out two months after the results feedback session as many people highlighted that they would not be available by the end of the third month as the summer holidays were approaching. Interviews were conducted at the local library and lasted twenty minutes on average.

Semi-structured interviews at the COPD group took place over three weeks, either at each groups' regular meeting venues or at a nearby park, before or after the participants' group sessions. Having been warned by the physiotherapists about how difficult it was to get in touch with patients once they had finished the therapy program (eight weeks), I decided to conduct the interviews three weeks after the results feedback sessions took place. From the twelve interviews planned just ten were conducted. Brandon was very ill for a couple of weeks and unable to leave his house or have a conversation over the phone. After his recovery, his attendance at the ARCaRe group was very sporadic as he started a course at university which conflicted with his pulmonary rehab group therapy. Bob was discharged from the rehab group as his health had improved considerably, and due to his work commitments, it was not possible to schedule an interview. The interviews with the COPD group participants lasted about 20 minutes, on average.

Table 5-1 Interviews planned and undertaken

Community group		ID	Participants' name	Observations
Primary School (Over 30 hour of field work)	*Children*	A	Sienna	School year: 5 Age: 10 Phone interview
		B	Aleena	School year: 5 Age: 10
		C	Kofi	School year: 6 Age: 11
		D	Jasmine	School year: 6 Age: 11
		E	Max	School year: 4 Age: 9
		F	Rosie	School year: 4 Age: 9
		G	Jason	School year: 2 Age: 7
		H	Dalia	School year: 2 Age: 7
		I	Safa	School year: 5 Age: 10
		J	Nathan	School year: 5 Age: 10 Did not attend interview
	Parent	A	Albert	Father (Sienna)
		B	Bianca	Mother (Aleena)
		C	Charlie	Father (Kofi)
		D	Dawn and Hanbin	Mother and Father (Jasmine)
		E	Elliot	Father (Max)
		F	Felicia	Mother (Rosie)
		G	Geraldine	Mother (Jason)
		H	Harriet	Mother (Dalia)
		I	Sahib	Father (Safa) Did not attend interview
		J	Omar	Father (Nathan) Did not attend interview
		K	Mrs Muller	Deputy head of school (Interviewed twice, before project took place and 3 months afterwards).
Parent and Baby Group (Over 30 hour of field work)		A	Tim	Father
		C	Daniella	Mother
		D	Adison	Mother
		E	Ella	Mother
		F	Martha	Mother (Spanish speaker)
		B	Ricky	Father
		G	Hugo	Father (not available for interview due to personal issues)
		H	Rose	Mother
		I	Mrs Roberts	Mother and gatekeeper
		K	Pilar	Mother
		J	Isabel	Mother
		M	Dora	Mother
		L	Roberta	Nanny (not available for interview as changed jobs)
Senior Citizen Group (Over 20 hour of field work)		A	Mr Woods	Group member and gatekeeper
		B	Lucy	
		C	Renata	
		D	Dona	
		E	Kiran	
		F	Helen	
		G	Penny	
		H	Claudia	
		I	Betty	
		J	Tomas	
		K	Maggie	
		L	Magdalene	
COPD Group (Over 20 hour of field work)	Group 1	B	Ed	COPD patient
		C	Mariana	COPD patient
	Group 2	D	Brandon	COPD patient (not available for interview)
		E	Cristina	COPD patient
		F	Marion	COPD patient
	Group 3	G	Laura	COPD patient
		H	Paul	Physiotherapist
	Group 4	I	Sam	COPD patient
		J	Martin	COPD patient
	Group 5	K	Tina	COPD patient
		L	David	COPD patient
		M	Bob	COPD patient (not available for interview)

5.3 Other sources of data - The Breathe London Project

During autumn 2016, semi-structured interviews were carried out with individuals who took part in some of the Breathe London Projects (BLPs). These individuals were mostly environmental campaigners and/or individuals who felt very strongly about environmental issues and wanted to do their part to help raise awareness of the air pollution issue among their communities.

The purpose of including these data sources in this PhD thesis was to provide further empirical evidence on the experiences of those who have taken part in participatory research interventions using personal air pollution sensors. Having the views of those who have carried out air pollution monitoring initiatives, on their own accord, would help me to better address my research question. Interviewing these participants gave me an understanding of the underlying reasons they had for proposing and taking part in the BLPs, as well as their experience of carrying out the data collection and the impact that this data had on their views and perceptions of air quality. Table 5-2 provides a summary of the projects in which the participants interviewed were involved. Further information about these projects can be found at http://www.breathelondon.org/.

Table 5-2 Breathe London Projects summary

Project name	Year	Aim	Main reported outcomes
The Dog Kennel Hill Primary School study	2014	To raise children and their families awareness to air pollution issues and their own exposure.	Families were able to identify the places where pollution was worst. Changes in behaviour to reduce air pollution exposure were expected (e.g. changing routes to go to school).
The 'Close the Door' Project	2014	To monitor the levels of pollution inside shops on a busy high street, and how these changes when doors are left open or closed during working hours.	Use project findings as evidence to help persuade retailers to implement a 'closed door' policy in shops on busy streets.
Pollution Warning for Cyclists	2014	To find out whether cyclists in London could avoid the air pollution they are exposed to.	This study demonstrates that cyclists could reduce their exposure to air pollution by choosing carefully the routes they take opting for quieter routes away from traffic.
South-East London Residents Study	2012	To illustrate the extent to which typical residents of South-East London are exposed to air pollution concentrations as they go about their normal day.	The findings from this study have been presented in numerous public meetings to raise air pollution awareness.
Open Streets London		To measure the air quality impacts of closing the road to motorised traffic.	The findings from this study demonstrate that air pollution could be significantly reduced by choosing to travel routes carefully and opting to walk though quieter routes away from traffic. It also demonstrates what could be achieved if certain roads are open to cycling and walking only, even just for part of the day.
MPs Measuring Air Pollution	2014	To show the MPs the air pollution they are exposed to and how they could relate air pollution measurements very closely to their daily activities.	This study allowed the participant MPs to have a greater understanding of the levels of air pollution surrounding them and the ways to reduce their exposure such as choosing to travel by train rather than in motor vehicles and choosing to walk on back streets rather than busy roads.
Modes of transport	2014	To gather air pollution measurements to demonstrate that the quality of the air people breathe in London is affected by what they do or where they are.	This experiment shows that there are things people can do to minimise the amount of air pollution they are exposed to when they travel around London, such as choosing commuting routes and modes of transport judiciously.

The Air We Share campaign	2015	To use peer-to-peer behaviour change to encourage Investec employees to take lower pollution routes.	The findings from this study have been used to raise air pollution awareness across all Investec employees, encouraging them to take simple to reduce their own exposure to air pollution and to reduce their future emissions. The findings of this study have also been shared with new employees during induction.
Crossrail - personal exposure monitoring	2016	To raise Crossrail employees air pollution, particularly, about air pollution exposure when using different modes of transport.	The project helped raise awareness of the dangers of air pollution and it also provided information about simple actions that could be adopted in order to reduce air pollution exposure, such as avoiding walking along main roads.

Twelve semi-structured interviews were carried out with the individuals who took part in the nine Breathe London Projects (BLPs) described in Table 5-2. Information about each of the participants interviewed is presented in Table 5-3 below. Participants were contacted via email and interviews took place over one month at different locations such as participants' offices, local cafes and parks and lasted 25 minutes on average.

Table 5-3 Participants from Breathe London Projects

ID	Participants Name	Breathe London Project	Interviewees role in the BLP project	Profession
A	Joseph	Modes of Transport	Participant (walker)	Accountant
B	Margaret	The Dog Kennel Hill Primary School study	Project coordinator	Writer
C	Robert	The Cycle to Work	ITV presenter	Journalist
D	Laura	Open Streets London	Project coordinator	Travel Planning Coordinator
E	Ben		Participant	Engineer
F	Daniel	Crossrail	Project coordinator	Crossrail Employee
G	Lila		Participant (walker)	Crossrail Employee
H	Lawrence		Participant (cyclist)	Crossrail Employee
I	Sophia	The Close the Door study	Project coordinator	Project Coordinator
J	John	MPs measure their own exposure levels	Participant	MP
K	Kate	The Air We Share campaign	Participant	Investec Employee
L	Ian	South-East London Residents Study	Participant	Pensioner

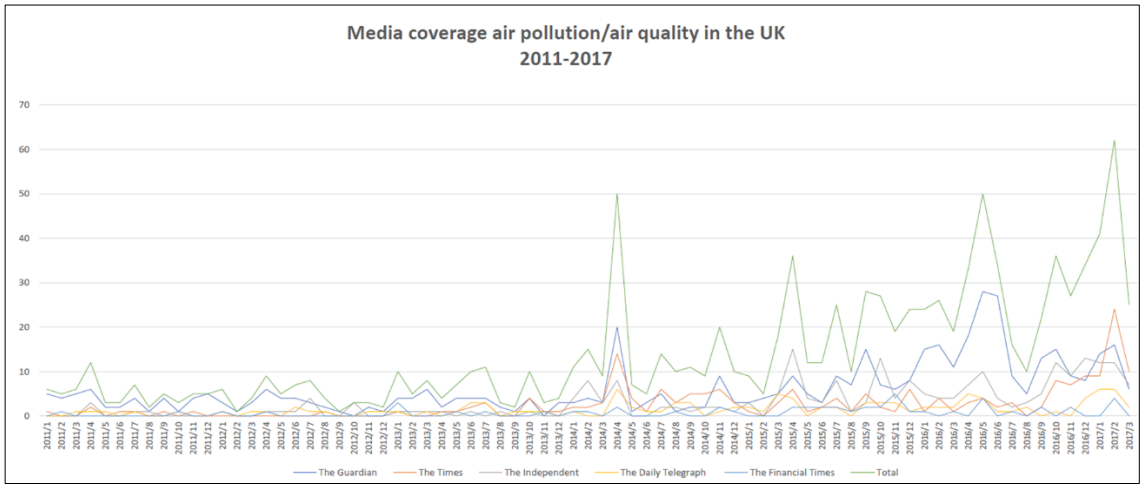
5.4 Media portrayal of air pollution

It has been suggested that the level of public concern about environmental issues tends to be proportionate to the amount of media attention received, therefore, public concern about environmental problems is likely to decline when media attention is shifted to a different issue (Mazur and Lee, 1993). It has also been reported that the media can make a contribution to public understanding of environmental issues, particularly global warming (Stamm et al., 2000, Friedman, 1991). Similarly, well established links between media reporting of health stories and the attitude and actions of the public have also been reported (Lupton and Chapman, 1995).

Therefore, while the perceptions and attitudes towards air pollution reported by the participants in this study, may have been influenced by their participation in the air pollution

projects, it is important to recognise that participants may have also been influenced by the media portrayal of air pollution. Thus, in order to understand the extent and type of coverage that the media was giving to air pollution/air quality during the period of field work (January 2015 - December 2016), the following section highlights the main air pollution related topics reported by the media over this period of time. This information was obtained from a preliminary media analysis (Kenis, 2017).

Using the automatic search tool NEXIS and doing manual checks, this preliminary work identified 1594 air pollution related articles in UK national newspapers The Guardian, Times, The Independent, The Daily Telegraph and the Financial Times between January 2011 and March 2017. While this work is not entirely complete, with articles from leading London newspapers omitted, it provides an overview of the media's reporting. Figure 5-6 below presents the air pollution/air quality media coverage in the UK between January 2011 and March 2017.



Source: (Kennis,2017)

Figure 5-6 Coverage of air pollution in The Guardian, The Times, The Independent, The Daily Telegraph and The Financial Times from January 2011 to March 2017.

It is possible to observe from the graph above that the first clear peak in the air pollution coverage took place in April 2014 where a combination of domestic pollution, emissions from continental Europe, dust from the Sahara and still weather conditions caused a sudden increase in air pollution levels across the capital. The second peak took place the following spring (April 2015), where a high-pressure system centred over Scandinavia resulted in settled conditions throughout south-east England and light easterly to south-easterly winds. Consequently, air arriving from the north of continental Europe mixed with local emissions to produce a widespread particulate episode across the whole region (LondonAir, 2018).

Between these two peaks, events such as the legal actions against the government for breaching European air quality limits, scientific reports estimating the mortality burden of air pollution (Public Health England, 2014), and press releases on the high levels of air pollution levels measures at Oxford street ("the highest in the world"), kept the media's interest on air pollution relatively high compared to previous years. This suggests that, by the time I started my fieldwork (January 2015), air pollution was starting to be highly portrayed in the media.

The next peak in air pollution media coverage took place in summer 2015, where air pollution was at the centre of the Heathrow third runway construction debate, and new report on the impacts of air pollution (Walton et al., 2015) was released. In September of the same year, it was found that automakers were using a 'defeat device' to defraud emission control tests. This incident known as the "the Volkswagen scandal/the dieselgate scandal" abruptly hit the headlines, and remained the focus of attention for months.

In January 2016, while air pollution was still in the headlines, a breach in annual air pollution limits, just one week into the new year attracted once more the media's attention. After this, the upcoming Mayor of London elections[2], where air pollution was part of most of the candidates' manifestos, plus warnings and further scientific reports on air pollution health impacts kept the topic of air pollution in the media. Following the elections, the media reports on air pollution focused mainly on the impact that Brexit could have on EU regulation of air quality. From September 2016, media reports on air pollution were frequent and varied in nature. Headlines during this period included: studies linking air pollution and deprived schools, new studies on air pollution impacts in particular areas (Boroughs) in London, Heathrow expansion approval, and the Client Earth victory against the UK government at the High Court. During this period, discourses about measures to reduce air pollution such as incentives for electric cars, diesel vehicle scrapage scheme and discussions about new charges for diesel vehicles to enter the city were also among the issues reported by the media. The last media coverage peak reported by (Kenis, 2017), was between January and March 2017. During this period, smog alerts issued by the mayor and the 'final warning' given by the European commission to the UK Government over air pollution breaches were among the air pollution stories reported by the media.

It is clear that air pollution/air quality related issues were being highly portrayed by the media during the time of my fieldwork. The information presented above will help with the contextualisation of the participants' narratives in the following empirical chapters.

[2] The 2016 London mayoral election was held on 5 May 2016.

The following chapters will present the findings of this study based on data from the observations, surveys and interviews conducted at the four community groups and on the data gathered from the interviews carried out with participants from the BLPs.

Chapter 6 - Results: Participating in air pollution monitoring

Introduction

During this study, I used a participatory research approach, endeavouring to get the study participants involved in the design and implementation of their own air pollution monitoring projects, as well as the analysis and dissemination of the project results. The empirical data presented here will focus on addressing the research sub-question of *"what motivates people to take part in participatory research which involves the collection of personalised data? And, what are the views and perceptions of those who take part in regard to their own project outcomes, expectations, interpretation of the data and further use of the findings?".*

This chapter begins by discussing the motives for taking part in this project. I then explore the participants' experiences of collecting their own air pollution exposure data. The participants' views and perception of their own project outcomes, as well as whether expectations were met and how results were interpreted and subsequently used and disseminated, are also presented. I conclude this chapter by discussing the feasibility and effectiveness of using this approach for engaging the public into air pollution discussions.

Throughout this chapter, I also present some of the results obtained from surveys conducted with the community groups that took part in this research project. These surveys were offered not only to those individuals that took part in the air pollution monitoring exercise but also to all members of the community groups that attended the introductory talk and or attended the project results session. The survey data gathered offer some insights into levels air pollution awareness prior to the air pollution project, as well as information about how the air pollution monitoring findings impacted air pollution views and perceptions of the surveyed participants.

6.1 The motives for participation

It has been suggested that some of the main reasons why members of the public decide to take part in participatory research initiatives are: personal interest in the subject, desire to learn, and concerns about the greater good (Rotman et al., 2014, Land-Zandstra et al., 2016, McCrory et al., 2017). Furthermore, it has been reported that many air monitoring studies which used participatory research approaches, had been driven by residents' concerns about air pollution in their local area based on sense perception, (e.g. the ability to 'see' fumes, 'touch' dust on a window sill) (Commodore 2017, Wakefield 2001).

As this study proceeded, it became apparent that the reasons for participation were generally different for each community group and that these reasons were influenced by participants' personal situation, cultural settings and individual interests. During this study participants reported that "gathering knowledge" was the main reason for taking part in the air pollution monitoring, However, as I report below, participants were seeking different types of knowledge for different purposes.

Knowledge to safeguard future generations

For the parents of the primary school children, the main reason for taking part was to find out whether their children were exposed to air pollution or not, and if they were exposed to air pollution, they wanted to know about the health implications. Parents' desire to know could have been driven by a duty to protect their children's health and their development. The following paragraph illustrates this.

> *"Because I am concerned about the pollution, the levels of pollution, there is a lot of traffic on the roads and I am really concerned about the, you know, health! especially respiratory health. Because, I see a lot of children, a lot with asthma and a lot of respiratory problems, and I think it's due to pollution, nothing else. I wanted to know the levels of pollution because then we can, you know, see! What is going on"*
>
> *Geraldine, Jason's mother, Primary school*

For many parent and baby group (P&BG) participants, taking part in the project was an opportunity to learn more about where and when their children could be most at risk of exposure, as well as how they could reduce exposure to harmful pollutants. Participation in the project was particularly important for those parents whose children had been diagnosed with conditions such as asthma and cystic fibrosis. Responses from most of the SCG participants indicated that their participation in the project was essentially driven by a desire to learn more about the subject. However, through conversations and interviews with the senior citizens, I got the impression that there was a strong sense of responsibility from many of them towards their community, particularly to future generations (many of them referring to their grandchildren). They were particularly concerned about the damage that pollution can cause to children's health and they showed to have a strong desire to identify ways in which this damage could be avoided or reduced. The interview extracts below illustrates some of the SCG responses when I asked them why they decided to take part in the air pollution project.

> *"I was quite interested to join the project really, because it was something that sort of interested me a bit, especially – perhaps not so much for me, but for young children,*

you know, my grandchildren and things, because that's – they've got a longer life in front which can be affected by it"

Betty, SCG

"Well I feel it's important that we know as much about how much pollution there is and what we can do to reduce it so that future generations are not affected by it so much. And also, that we're using less and less resources because resources are finite. And the ones we use – petrol, diesel fuel, are going to burn out. And we need to start replacing them but replacing them with something that's not going to cause more pollution".

Claudia, SCG

Knowledge to safeguard self

There was also a marked desire to gather knowledge for safeguard self from the dangers of air pollution. This was mostly observed from the COPDG participants, who noted that the main reason for taking part was to identify which areas in their neighbourhood where likely to have high levels of air pollution. Their interest in 'knowing' was strongly motivated by their desire to identify ways in which they could safeguard their health condition by reducing their exposure to pollution. In contrast with many of the participants from the senior citizen group, who visited different areas outside their normal routines, most of the COPD participants reported limiting their air pollution monitoring to their normal routines. This was probably a reflection of the COPD participants' health condition, which restricted the amount of time they could spend outdoors. Some COPDG participants avoided going out as much as possible, as they felt that they would become unwell if they went out "because of the air pollution".

In a similar way, Sean (COPDG physiotherapist), also seemed to have a strong interest in using the monitor to identify the less polluted routes within his working area, so he could cycle along these routes and reduce his own exposure to air pollution. Sean cycles everyday between different venues to carry out the rehabilitation sessions and to visit patients at home across the borough.

Knowledge to assess the local magnitude of the problem

Many of the respondents across all groups, including individuals from the Breathe London Project (BLP), reported that although they were, to some extent, air pollution aware, they didn't really know about the magnitude of the problem in their local area. For instance, when the project was taking place at the P&BG, major infrastructural developments were being carried out in the area. The local area was having to deal with unprecedented levels of vehicular flow along the main roads with residents particularly concerned about the extent of the impact

that this could have on local air quality. Participants across all groups also highlighted their concerns about the impact that living near areas with heavy traffic and, or near areas which were being developed could have on the air quality inside their homes.

Knowledge to build evidence to advocate for change

It was also reported by some participants across all groups that the air pollution monitoring project was an opportunity to gather evidence which they could present to the local council and developers to show how air pollution was affecting the neighbourhood. For the BLP participants, the main reason to participate was to gather evidence to support their claims and to raise awareness among their communities and, or, to advocate to those in charge of shaping and delivering policy intervention to tackle air pollution. The extract below illustrates this.

> *"It was a fantastic opportunity really, we need to convince people here that it is actually happening and to carry a monitor and to be able to see that it's science based, and these are the graphs, and these are the numbers, that made a huge difference and really changed people, made them much more aware"*
>
> *Kate, Investec employee, BLP*

Knowledge as an end it is own right

For the primary school children and their parents, the main reason for taking part in the project was to gather knowledge, 'to know'. Children reported a desire to 'know' could have been linked to the nature of their school environment, where there is an intrinsic expectation that you attend school to 'learn'. Similarly, the senior's citizens' desire for "knowing" was in line with their community group context. The group of senior citizens in this study were part of the University of the third age (U3A), whose members are characterised by their desire to continue learning.

6.2 Active collection of data

One of the characteristics of participatory research is the innovative adaptation of conventional methods, using them in new contexts and in new ways of involving local people (Cornwall and Jewkes, 1995). Advances in sensor technology means that individuals can now monitor air pollution levels themselves using relatively cheap, accurate and straightforward portable equipment (Jerrett et al., 2017). However, many participatory research approaches which involved air pollution monitoring, have used fixed site monitoring (Commodore 2017). Therefore, little is known about the experiences of those who carry out personal mobile air monitoring equipment.

During this project, participants had the opportunity to carry air pollution monitors as they went about their daily routines. Participants' commuting involved different modes of transport (e.g. walking, train, underground and cars). These specific and small areas where people can potentially come into contact with harmful pollutants are known as 'microenvironments' (Nieuwenhuijsen, 2015). This section focuses on participants' reported experiences of carrying and operating the portable air pollution monitor, as well as on the participants' views and perceptions of their own project outcomes, including whether their expectations were met.

6.2.1 Ability to use the monitors to collect data

Most of the individuals interviewed reported no problems while handling the air pollution monitoring equipment (turning monitor on and off and charging unit) and GPS watches (turning GPS on and off and changing batteries). Similarly, there were no major issues reported regarding filling the activity diary. However, some people reported that they had not fully realised the importance of accurately recording the diary entries until after receiving the reports. For example, some participants wrote in the diary that they were at home, but they did not specify what they were doing (e.g. cooking, smoking, working in their wood workshop sanding wood etc). This ambiguity in the description of the activities made, at times, difficult the description of the findings as I was not sure about the source of pollution. This was also an important understanding for me, as I realised that I should have perhaps emphasised more the accurate and precise diary entries as these are important to better contextualise and understand the findings.

6.2.2 Collecting my own data – a fun, exciting and stimulating approach

In general, children from the primary school project perceived the active collection of air pollution data as 'fun' and 'exciting', many of them reporting their enjoyment of carrying a monitor outside school to measure their air pollution exposure. Parents also reported that children were very excited throughout the project and that they were very pleased that their children were learning something important while having fun. I received a similar feedback from Margaret who was very passionate about air pollution issues and who had coordinated the Breathe London - 'Dog Kennel Hill Primary School Study', she argued that methodologies which involved the active collection of data have the potential to be effective tools to engage with school children.

> *"I think it made a huge difference in terms of their interest in the project. But, you know, the feeling that they were doing science themselves and that they were contributing to a class project and contributing to a wider study. I think that was really motivating and, yes, made them curious about what the results were in a way that, you know, than if I'd*

just been coming in to the school and setting up a monitor in the corner of the playground or something. That would have been interesting as well, but not quite as helpful as them doing it themselves. And then being able to recognise –That was the route, that was me, that was the route that I walked."

Participants from the P&BG reported that participation in the project gave them the opportunity to carry, what many considered, a 'sophisticated machine' (referring to the air pollution monitor). Some noted that being able to see how the monitors work and what sort of data they can collect was a stimulating and informative experience. For most of them, having the opportunity to carry a 'machine' which could measure their 'invisible' personal exposure to air pollution and make it into something which they could 'see', was a trigger for participation.

"The fact that you had, it was not only a questionnaire or trying to talk about it, it was actually that you had a machine really individual for everybody, so I could during that day really know about my own experience and I like that. That's one of the main reasons also I took the part because I had that machine that really controlled me"

Pilar, P&BG

All participants from the SCG were eager to collect their own air pollution data. They were enthusiastic about having something 'new' to do and some described this as an 'adventure'. Many designed their own monitoring strategy where they incorporated visits to areas of concern, (e.g. main roads, junctions and constructions sites) into their daily routines. An example of this is Tomas's plan, which included a visit to the area where one of the local automatic monitoring sites was located. Tomas wanted to measure the air pollution levels around the monitoring site, so he could compare this data against the freely available data recorded by the automatic monitoring equipment. Some senior citizens also reported taking the air pollution monitors to their children's neighbourhoods and homes, as they wanted to know if their families were being exposed to harmful pollutants. This duty of care for future generations was characteristic of the senior citizens.

Many participants from the SCG also perceived the involvement in the air pollution monitoring projects was an opportunity to do something important and meaningful. The following extract from Mr Woods, from the senior citizen group, illustrates what many participants thought about their role in the project and how they felt that they could effectively contribute to research.

"I think it gave me an appreciation of the role that non-scientific professionals can play in actually contributing to a scientific study or sort of like citizen science type of initiative. And that research teams can benefit a lot by getting volunteers to get out there in the field and do some data collection for them. It has the added advantage that the non-scientists, the non-researchers, have a feel that they've contributed and participated in some way, which could help to make the subsequent analysis and the results and the inferences to be drawn, more accessible to the public. If we can promote it as a sort of citizen science initiative where the public took part, rather than 'this is just something that the research team have found,' and they're presenting it back. So, I think that what came over is there's a definite role for ordinary people in engaging in scientific research"

Mr Woods, SCG

For Mr Woods and for many other participants, gathering the data themselves made their data (in their eyes) more credible and accessible. Air pollution monitoring was not something that could only be done by a closed circle of scientists, instead, during this study, participants had the opportunity to be an active part of the research process, gathering the data themselves. Participants, in general, did not talk about 'citizen science' or other forms of participatory research. Therefore, Mr Woods' remarks (above) about 'citizen science' were uncommon but not necessarily unexpected from a SCG participant. Mr Woods was not only the leader of the senior citizen group, one of the UK groups of the University of the Third Age (U3A), in his spare time he was also involved in various activities within the local community (e.g. gardening, reading group). Furthermore, Mr Woods also told me that he attended, on regular basis, lectures and conferences at various universities in London in a variety of topics. Therefore, it is very likely that Mr Woods had previously heard about 'citizen science' and what it entails (e.g. opportunity to gather data) and as a result he made the association between our air pollution monitoring project and the citizen science concept.

The air pollution project was also perceived as something important by various members of the P&BG, however, this may have been due to the events taking place at the time. When the air pollution measurements were taking place at the P&BG, the London mayoral candidates were carrying out their political campaigns. Some of the candidates decided to highlight their commitment towards tackling air pollution by carrying out air pollution measurements themselves on some of the most polluted areas of the capital (e.g. Oxford Street). The instruments used by the mayoral candidates for measuring air pollution were the same as those used by the participants in this study. Some participants from the P&BG reported seeing media

reports about the candidates' air pollution monitoring and described feeling thrilled to be part of a similar project.

6.2.3 Understanding my data

Participatory research is considered a co-learning process, characterised by the reciprocal transfer of knowledge (Israel et al., 1998), emphasising in a process of mutual learning and analysis (Cornwall and Jewkes, 1995). However, it can be argued that it is not possible to have a "reciprocal transfer of knowledge" when those individuals involved in the research process do not have the same scientific expertise as the researcher. I will argue that, in participatory research the idea of 'working with rather than on people' implies some form of two-way conversation between the participants and the researcher. For example, during this study, I encouraged participants to contribute to the understanding of the data findings. Participants who carried out the air pollution monitoring received individual reports of the data they collected. Following this, I met with participants individually to explain the graphs and maps contained in their individual reports, to give them the opportunity to ask questions and to ask them if they could explain some data entries which were not clear to me (e.g. recorded high levels of air pollution in unexpected places, such as quiet back streets). Participants across all groups actively contributed to the understanding of their own data, following the graphs and maps in their report they talked me through their findings. One example of this was Aleena's (age 10 - from primary school project) case. While walking back home from school carrying the air pollution monitor and GPS watch, Aleena recorded unusually high levels of air pollution in one particular area, which as per GPS coordinates, looked like a quiet residential street. It was not until I interviewed Aleena, and we looked at the maps together, that she remembered and explained to me that when she was taking the measurements there were some trucks delivering building material to a new development site on that day at that particular location. Having this two-way conversation with Aleena meant that I was able to identify the source of the high pollution readings and therefore, I could tell her a little bit more about her data. For example, that the source of pollution in her local street was not permanent, but that this was a good example of how stationary vehicles with the engine on can also contribute to the air pollution problem.

Another example was the measurements carried out by Dona, one of the senior citizens. When I processed and plotted Dona's data, I noticed that there were unusually high levels of BC recorded while she had the air pollution monitor in her house (as per diary and GPS coordinates) (Figure 6-1).

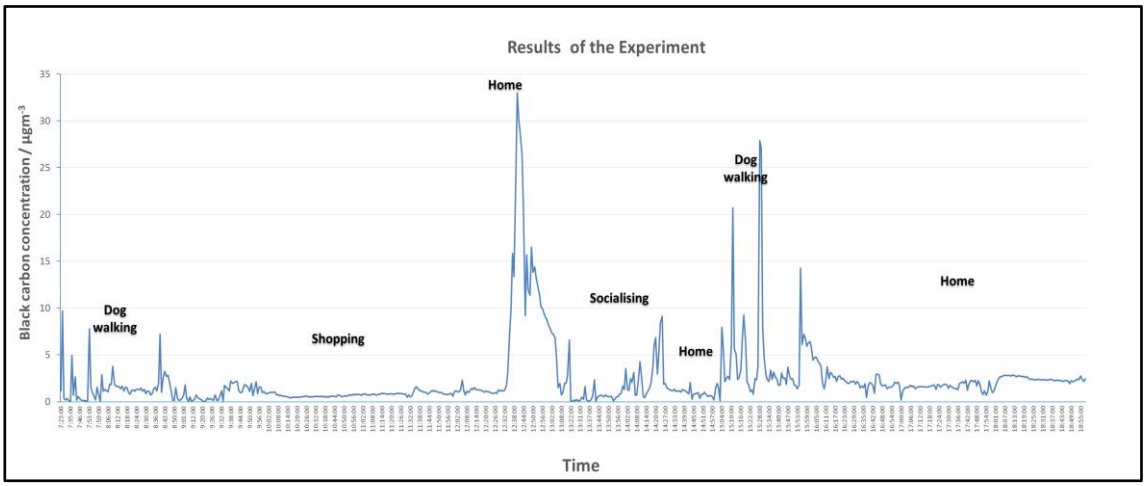


Figure 6-1 Air pollution monitoring results from senior citizen Dona.

Initially, I thought that the unusual high BC levels recorded could have been due to cooking activities. Dona was very intrigued with the findings as she said she was not cooking that day. However, while looking in detail at the data together, Dona remembered that during that period she was with some friends in the conservatory and as it was very cold, she was using an old gas heater appliance. In this case, Dona was very eager to identify what was the likely source of pollution, particularly because she felt that, since the source of pollution was inside her home, she may be able to do something about this and as a result reduce her and her family's exposure to harmful pollutants.

Collecting personal exposure data demonstrated particularly well the issues that arise from what might be regarded as just ordinary activities "going about one's business". Additionally, collecting data using a mobile monitor (instead of a static monitor at a particular road or junction), made clear the links between the findings and the particular circumstances, (e.g. being inside a London taxi, going on the London Underground, going around the city centre). This encouraged some participants to try to reduce their air pollution exposure as the following extract illustrates.

> *"The public transport probably gave me more exposure to these particles than walking, because I can choose where I walk, I suppose, away from main roads. Being mindful of that and aware of that at least gives you an opportunity to manage your exposure to it. So, if you're going to walk from A to B, there's an option to take a route through less busy roads, one might be encouraged to do that, whereas before, one might not have thought about that and just, you know, gone along the busy high street. So, I think that's a possible outcome".*
>
> *Claudia, SCG*

6.2.4 Measuring air pollution, a complex affair

Taking part in this project allowed many participants to encounter first hand some of the complexities of measuring air pollution. For example, some of the participants reported realising how factors such as seasons and weather patterns (e.g. wind speed and direction) could influence the concentrations of pollutants in the air.

> *"I guess there's a lot of variables is what I've realised. You can just say, like I say walking along the river is probably better on most days but there are boats on the river and there is a lot of exhaust from those boats or you'll see black cabs in the thoroughfare idle. So, I guess the thing is you avoid maybe certain areas but then also understanding that there's, not one place is always going to be best or always going to be worst if that makes sense"*
>
> *Rose, Mother, P&BG*

Many study participants highlighted that having air pollution experts at hand (referring to my supervisor and me) was vital for the designing of the projects, understanding of the data obtained and for the clear dissemination of results. An example of this was the Open Streets Project, from the BLP, where high concentrations of PM_{10} were recorded by the participants while walking along a street without traffic. Laura, the coordinator of this project, explained that the air pollution expert (referring to my supervisor) had warned her about other possible sources of pollution different from traffic fumes. Therefore, when looking at the data gathered, she understood that the origin of the high concentrations of PM_{10} recorded, were likely to have been emitted from a restaurant kitchen which was "spewing out some sort of smoke" while the measurements were taking place. Furthermore, Laura said that through conversations with the air pollution expert, she understood that the data collected could not be scientifically 'significant' as there were too many variables that could not be controlled. However, she also highlighted that taking the measurements and getting involved in the project was of great value for learning about air pollution and raising awareness, despite the lack of scientific value of the data collected.

The support given to each of the BLPs (BLPs were mostly 'activists', individuals who felt very strongly about environmental issues) included the processing and analysis of the air pollution data gathered. However, some participants wanted to try to process the data themselves and they asked us for instructions on how to do this. These individuals later reported to have found the data processing process difficult due to the lack of standardised procedures and, or protocols they could follow. They also highlighted that the interpretation of the findings was at times difficult, and that support from an air pollution expert was required

to understand the findings. The experiences reported by the BLPs contrast with Steve Epstein's claims in relation to early AIDS treatment activism. Epstein's (1995) argued that in order to construct their scientific credibility, treatment activist focused on learning the language and culture of medical science. Activist considered that in order to make their participation effective, they should be able to not only understand but also to 'speak' the language of the different subjects surrounding AIDS (e.g. mechanism of drug addiction) (Epstein, 1995). Therefore, while participation in the BLP projects appeared to have increase participants scientific literacy, the assistance of an expert, particularly to interpret the data sets, was still needed. It could be argued that, the ability to interpret scientific complex sets of data (e.g. air pollution data) which can be influence by many variables (e.g. local and non-local sources of pollution, wind, rainfall etc) requires not only traditional learning but also experiential learning.

While most participants across all groups noted that they would have liked to carry the air pollution monitor and GPS watch for a longer period, so they could visit different places and carry out different activities, a small number reported feeling uncomfortable using the GPS watch which could reveal their exact location. This could have been perceived by participants as an invasion of their privacy.

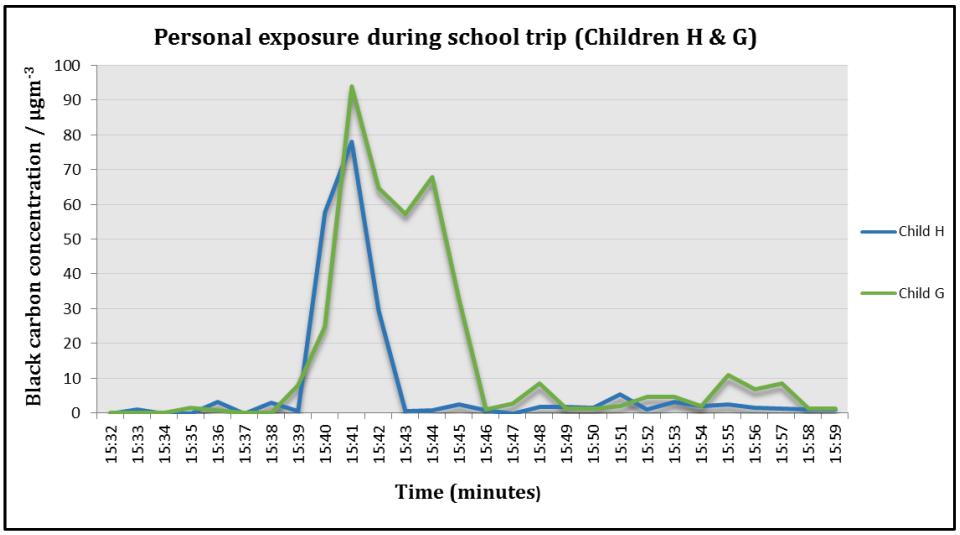
For the community group members, undertaking the air pollution monitoring was not always a simple affair. Some of the participants reported feeling anxious when carrying the monitor into public places as they received 'strange looks' from other people. Roberta, a nanny from the P&BG, certainly had the worst experience. She was stopped and interrogated by the police while travelling in the London Underground, as one of the fellow passengers reported to the police that there was a woman carrying an 'unknown weird looking device'. Fortunately, the police promptly checked the 'device' and verified that this was indeed an air pollution monitor and allowed Roberta to proceed with her journey. This episode did not discourage Roberta from continuing with her monitoring, but it made her very uncomfortable.

6.3 Expected and unexpected findings

From my informal conversations and interviews with participants, it was clear that many of them were inclined to associate high levels of air pollution with heavy traffic, even before seeing any results. Thus, it was not particularly surprisingly for many of them to see that the highest levels of BC were recorded along busy roads and at junctions. In general, they reported that the data collected not only corroborated what they already knew in terms of sources of air pollution, but also gave them a sense of the magnitude of the issue in their area. Furthermore, participants highlighted that although there was almost an "implicit expectation" that levels of

air pollution would be higher on busy roads, some of the findings were unexpected, as there were some sources of air pollution that people did not anticipate.

For the school community (children, parents and teachers), the biggest surprise was to discover that idling vehicles parked outside the school or anywhere in their neighbourhood could contribute to the air pollution problem in their area. A set of data gathered by Dalia and Jason (both age 7) just outside the school gate (Figure 6-2), shows how both children were exposed to remarkably high levels of diesel exhaust emissions 'black carbon' during 5 minutes while they stood next to an ice cream van compared to their rest of the route back home (Varaden et al., 2018).



Source: (Varaden et al., 2018).

Figure 6-2 Air pollution monitoring results Dalia and Jason

Identifying that there were possible sources of indoor air pollution such as those emitted from gas cooking activities and gas heaters was particularly surprising for many of the participants from the SCG and COPDG. Emissions from candles and incense used in church services and during meditation classes were recorded by Claudia from the SCG and David from the COPD groups. Despite feeling very surprised by the findings, the impact that the data had on their daily routines was different. Claudia continued attending the church services as she thought the pollution recorded from the incense was not harmful and it might even have medicinal value. David, on the other hand, was more concerned:

> *"I was doing mindfulness for an hour with the shrine moon. And whilst eyes were closed, I noticed I was struggling to breathe, and so I looked, and towards the altar there were like eight candles burning and incense. So that immediately tells me that there is, particularly with the atmosphere, it could be black carbon from the candles. And so*

that's an explanation as to whenever I go to that place, I have trouble breathing, which I didn't know about before. I suppose it could be the mice there, could it have been some other allergic reaction? I'm pretty sure now it's the incense and the candles burning. So, I might have to alter where I practise my mindfulness now because of that, because otherwise I would never have known. I'm sure it occurred to me that everyone else sitting in that room had no idea that those candles burning could cause perhaps problems for people with difficulties"

David, CODPG

Reducing air pollution exposure was not an immediate priority for Claudia (SCG), possibly because she was not feeling unwell during or immediately after exposure. However, individuals like David who suffer from COPD are particularly vulnerable to the harmful effects of air pollution, and even short-term exposure to air pollutants can induce acute exacerbations (Holgate et al., 2016) (Li et al., 2016). David, like most COPDG participants knew that there was a real and imminent possibility of becoming unwell due to being exposed to harmful pollutants as this information was highlighted previously by the physiotherapist. Therefore, COPDG participants were in general motivated to identify sources of pollution, so they could then take the necessary measures to reduce exposure and hence the worsening of their symptoms.

Another major surprise for participants who used monitors while travelling on public transport was to find out that their exposure to air pollution was likely to be higher when travelling on public transport compared to their exposure when carrying out outdoors activities (e.g. walking and cycling). This was a matter of concern for many participants, particularly for those who used buses as their main local mode of transport.

The air pollution measurements carried out by senior citizen Tomas, were particularly puzzling as they were taken while travelling on a single bus through a quiet countryside road, during both, the outbound and inbound journey (Figure 6-3).

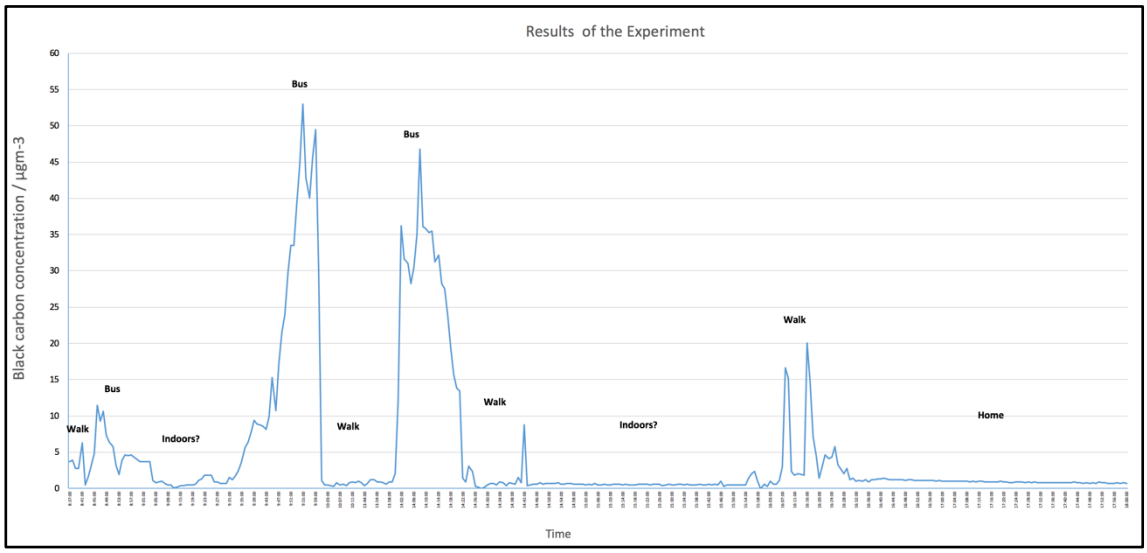


Figure 6-3 Air pollution monitoring results from senior citizen Tomas

Tomas was particularly concerned and asked me if he could do the monitoring exercise again as he wanted to make sure that there was not a technical issue with the monitors. Tomas carried out the measurements again, this time in the company of his wife. Each of them carried a black carbon monitor, Tomas sat at the back of the bus while his wife sat at the front. They did the measurements for the full length of each journey (outbound and inbound journey). Each journey took approximately 45 minutes. The bus was a single decker bus with a single door at the front, with a diesel engine and travelling through country lanes (without traffic). Tomas' findings from the second monitoring exercise still showed remarkably high levels of BC, especially at the back of the bus during the outbound journey, where the average BC value recorded was (16.93 µg/m^{-3}) compared with the average BC recorded at the front of the bus (6.76 µg/m^{-3}). The inbound bus journey levels registered were lower and more in line with those measured by other participants. At the back of the bus the average exposure was (4.51 µg/m^{-3}) while the average exposure at the front of the bus was (5.34 µg/m^{-3}). During the second experiment, Tomas was very observant of his surroundings as he wanted to make sure he spotted anything that could affect the results. He took note of departure times, average traffic flow and he even noticed that the windows of the bus were open during the inbound journey and suggested that this probably allowed air in and out of the bus cabin. Although, Tomas's second experiment still showed high levels of air pollution inside the bus, Tomas was pleased to know that the results were similar to those from the first experiment, therefore indicating that there were no problems with the monitor or that he had done something wrong the first time around. Tomas highlighted that although he thought that his findings were interesting, he did not think that people would take any particular interest in these results.

"I think that the specific data, not really. I mean nobody would be interested. It's what inferences that can be drawn from it by, you know, conventional route of peer reviewed analysis".

Tomas, SCG

Tomas' findings were presented and discussed with all the senior citizens during the feedback session, and contrary to what he initially thought, senior citizens found these results very concerning as many of them used buses as their main mode of transport. Participants had many questions regarding the findings, including whether this bus was representative of all London buses, if there was anything, they could do to reduce their exposure while travelling by bus and who was responsible for ensuring that buses were in good working order. It was particularly difficult for me to answer these questions as there was not enough evidence to draw any conclusions. I answered that this small study could suggest that this was a particularly defective bus "self-polluting" (when the bus own exhaust can be found inside its cabin (Marshall and Behrentz, 2005)), not representative of all London buses, and that it was likely that sitting near the door and or opening the bus windows could reduce air pollution exposure as the air inside the cabin would have a better dispersion. The questions regarding accountability were answered by other members of the group who suggested contacting the Local Authority and TFL.

Around the time when this project was taking place, I was contacted by Chanel 4 journalists, who wanted to know about my current work. I told them about the senior citizens project and some of their findings. The journalists found Tomas' findings very interesting and were eager to learn whether this bus was representative of all London buses. Therefore, they asked me to help them set up a study to follow up on Tomas' findings. The findings from the journalists' study suggested that the bus from Tomas' monitoring was an isolated case, not representative of all London buses[3].

While it is clear that the media's involvement in this project helped with the dissemination of the results, what I found particularly interesting was the underlying reasons for the journalists to take an interest in this project. The journalists told me that for them it was particularly appealing to broadcast an initiative which has its roots in the community, as they feel that this could attract viewers which would feel identified with the local issues presented.

Many participants found that the data gathered while travelling on the London Underground was surprisingly higher than any other data recorded, with some describing these findings as

[3] The results from the journalists' study can be view at https://www.youtube.com/watch?v=6f33z5PtEow

'shocking'. Great efforts were taken to explain to the participants that above ground, the monitor measures Black Carbon (BC) which is one of the components of fine particulate matter ($PM_{2.5}$) and a strong indicator of traffic related emissions, specially diesel and which represents a component of air pollution thought to have amongst the greatest potential risk to public health (World Health Organization, 2012b). I explained to these participants that when in the London Underground the monitor did not only sampled BC, but also a range of particulates including black carbon and metal particles from rail, brake and wheel wear. Participants were also informed that recent research has suggested that the presence of metal particles can overestimate the concentrations of BC measurements in the Underground due to metals such as iron interference and that it was still unclear whether the air in the Underground was more or less toxic than the outdoor air (Moreno et al., 2015).

Despite my best efforts to convey the known information about the reasons and implications of the high air pollution readings in the Underground, many participants did not seem to be satisfied with the explanation. Even though they were made aware of the complexities of measuring air pollution (e.g. identifying different sources of air pollution), explaining information about the uncertainties of science in general was very challenging. Participants, in general, found very frustrating the fact that there was no conclusive evidence as to what exactly they were breathing while on the Underground and how this could affect their health.

Participants across all groups were also surprised by the findings from the data gathered while traveling in a vehicle, which showed that air pollution concentration were higher when travelling inside a car compared to walking on the pavement. Some commented that before seeing the findings from the project they thought that being inside a car 'protected them from air pollution'.

Lawrence was particularly reassured to know that when cycling he was usually less exposed to air pollution compared to travelling by car or public transport. He said:

> *"I actually thought that I was making a personal sacrifice in terms of air quality exposure. I thought that I would actually have a harder or a worsened daily exposure. So, it's quite positively surprising if that's not the case"*
>
> *Lawrence, Cyclist, Crossrail Study, BLP*

6.4 The impact of taking part in community-based projects

In the following sections, I comment on the impact that participation in the air pollution monitoring projects had on community group members' short and mid-term perceptions of and attitudes towards air quality.

6.4.1 Air pollution awareness and understanding

In general, participants across all the community groups reported that taking part in this participatory research project had boosted their level of air pollution awareness and hence, their understanding of the issue. Through this understanding, participants had the opportunity to analyse their own situations (e.g. places and times where they were most likely to be exposed to air pollution) and to propose solutions to reduce exposure to harmful pollutants and or reduce their own contribution to air pollution. For example, through informal conversations and interviews, I noticed that following participation in the project, children tended to talk with more familiarity about the effects that air pollution could have on their health and some of them were able to identify highly polluted areas within their neighbourhood. Most children said that they did not have any previous knowledge about air pollution before the project and many of them agreed that if they were to remember what they had learned about air pollution, the information had to be repeated on regular basis. The findings from the surveys conducted with the children from the primary school, (including those who were not part of the air pollution monitoring project) also seem to suggest that having access to the air pollution project results may have enhanced the children's knowledge and understanding of the issue (Varaden, 2018).

Similar accounts were recorded from the senior citizens, who said that the project had permitted them to "see" where exactly they were being exposed to air pollution, and this, as a result, inspired them to think about ways in which they could reduce their air pollution exposure. They also highlighted that by taking part in the study, they had learned more about air pollution, so they could "speak up" confidently about the issue with family and friends. The following extract is an example of some of the conversations participants had with other people about air pollution in their area.

> *"So when I was going on a country walk, after I got my results from you, I was telling this man about it, that I know, you know, from the walks. And he used to work for Lewisham council. And when I said, you know, the pollution was much higher on the 246 bus going into Bromley than the 119 coming back, he said, that would be because it has a certain type of engine. And I mean it was a bit over my head, the technical details of that. But he wasn't surprised. So he must have had an idea that there was some, you know, some difference in things. Maybe the newer buses are better. The 119 is quite a modern bus".*
>
> *Betty, SCG*

During my time spent at the COPD groups, I noticed that participants from this group seemed to be talking with more familiarity about air pollution impacts on health, particularly respiratory health. This was not surprising, as many of these individuals had spent years dealing with their health conditions, attending numerous doctor appointments to discuss their health. Therefore, it is possible that participation in the air pollution project did not add much to these participants' awareness in this regard. However, they reported that participation in the project had provided them with information about local air pollution hot spots and about ways in which they could reduce air pollution exposure, and as a result, changed their routine to reduce air pollution exposure.

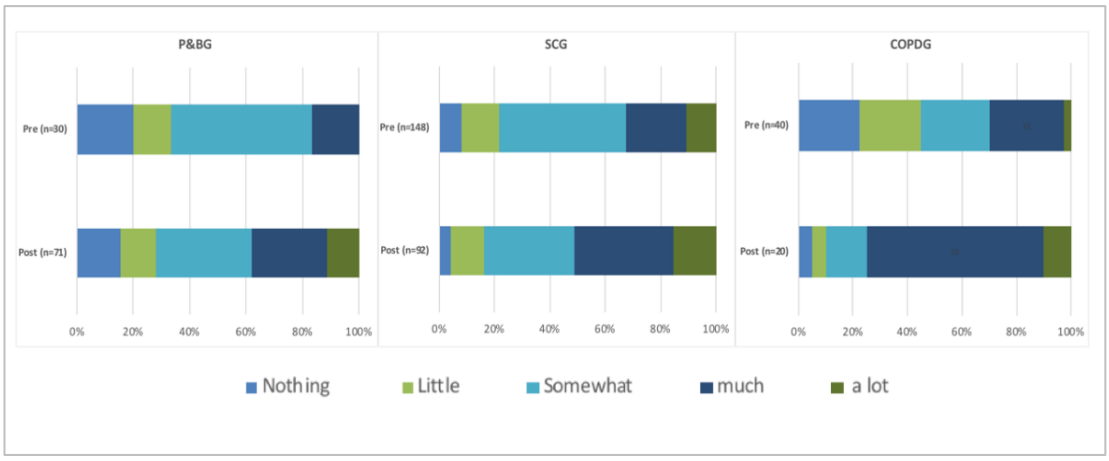
> *"I know, you know, with my lung condition and that, I know a lot about it and that. I didn't know a lot about pollution and everything. But I must admit, I do know a lot now, you know. And it has made me think more about where I'm walking and, you know, what I'm doing and things like that. So yes. I'm really glad I've done it, I'm really glad I've done the project"*
>
> *Mariana, COPDG*

Most participants from the Breathe London Project (BLP) reported that although they had some understanding about air pollution before taking part in the BLP, participation in this project helped them realise the urgency and magnitude of the problem. An example of this is the view of Mr Williams, Member of Parliament:

> *"I was fairly engaged in the air quality issues previously and certainly I am now. I'm very much involved in what my constituency is trying to do as far as its own air quality is concerned. What I would say has changed is my, my perceptions of how air quality works areas. And that's given me a much more, I think, sophisticated version of something that I was aware of and, I think, reasonably understood previously. But actually, it's taken that understanding to a much greater level, I think"*
>
> *Mr Williams, Member of Parliament, BLP*

Mr Williams also stated that, as a result of participating in the BLP, he had started to think in more detail about the different sources of air pollution currently affecting his constituency and the possible policy interventions that could be adopted to tackle the issue.

To assess the impact of participating in air pollution projects on people's awareness of air pollution, members of the community groups were asked, "How much do you know about air pollution?" before and after the project took place. Figure 6-4 presents the responses obtained.



Question 4, How much do you know about air pollution?

Figure 6-4 Pre and post survey results

The pre-survey results suggest that the biggest proportion of respondents reported knowing 'somewhat' about air pollution while the post-surveys' findings showed a marked increase in the proportion of respondents who reported knowing 'much and 'a lot' about air pollution. An apparent reported increase in air pollution knowledge between pre and post intervention is also observed through the reduction in the percentage of participants who reported knowing 'nothing' or 'little' in the post-survey compared with the pre-survey. The percentage of participants who reported knowing 'a lot' was generally low compared to the other responses given. However, the percentage of people reporting knowing 'a lot' was higher in the post-surveys compared to the pre-surveys. The dynamic nature (high turnover of group participants) of most of the groups meant that some of the participants surveyed before the project, had left the group and were replaced by new participants for the survey conducted after the results were presented.

6.4.2 Air pollution real and relevant

Many participants across all groups reported that taking part in these projects made the air pollution problem relevant to their daily lives, by making the presence of harmful pollutants in their local surroundings real. Participants expressed the view that although they were aware of the dangers of air pollution, the active collection of personal air pollution data had made the issue more personal.

> *"I think, yes it made it a bit more real and a bit more personal because, prior to that, it's not something I've ever studied, only looked at articles as they appear in the press or in the popular science press, so, but you don't really register. Whereas if you take part in something and you have that personal connection, it has a more immediate resonance. So, you think about it a bit more and you think about what you're doing a*

bit more. So, I think that was a – that was a real value about engaging people like myself, because it does bring home to us the personal implications".

Betty, SCG

In the following paragraph, Robert, journalist and participant in the Breathe London- Cycle to work study argues that local evidence-based interventions can be useful for awareness raising.

"I think if people are, yes if people have a direct involvement or like the project you were doing in the schools, for example, I think that if people are seeing, "This actually isn't just a general news story about everything, this is a story that's been done at my school and we've noticed on these routes, it makes a difference." Yes, that sort of hands on experience and the local, personal touch is really important, I think, to get the message across"

Robert, Journalist, Cycling to Work Study, BLP

Many participants across all groups reported that despite having received information about the common sources of outdoor and indoor air pollution during the introductory talks, they did not appreciate how this information was relevant to their daily lives until they carried out the air pollution measurements. Similarly, participants also expressed the view that general information alone was not enough to trigger changes in practices to reduce exposure to harmful pollutants. Many participants considered that information and advice based on personal information gathered by local people such as the information collected through these monitoring projects, was much more effective.

6.4.3 Inspired action

While conventional research tends to generate knowledge for understanding, most participatory research focuses on 'knowledge for action' (Cornwall and Jewkes, 1995). A core aim of any participatory intervention, is a commitment to action, where information is generally gathered to inform 'action' in order to enhance the wellbeing of those involved in the participatory research process (Israel et al., 1998). During this study, many participants across all groups, highlighted how the knowledge gathered throughout the project had helped them to start making informed decisions to manage their exposure to air pollution. An example of this is an extract from David's interview below.

"It was empowering to be able to know that I have, I can pull back some element of control within it. So, for example, when I came here today, I could easily have taken the bus from outside of my house. But I chose to walk down some back streets and take the

DLR, because I know that is, there is less pollution on those streets and on that DLR train. So, it does affect how I move, how I use public transport, greatly"

David, COPDG

Having knowledge that could be translated into action was also appreciated by many of the participants from the P&BG. Some did express the view that knowing that air pollution was right at their door step "was an extra worry to add to their lives", yet they also highlighted that knowing that there were small changes they could make to their daily routines to help reduce their children's exposure was a relief. For many participants, particularly for the parents of small children, it was important to feel that they had certain degree of control over the issue. The following extract illustrates.

"In a way it's something else to worry about, you worry about certain things with the kids but also can be a relief I guess if you know the information instead of no knowing the information cos then you kind of approach it. I guess the knowledge is what's going to empower you, like actually knowing what the risks are. Yeah, I guess that's, I guess that's, in a way you feel a bit helpless cos there's like very little that you, as long as you live in London there's going to be exposure but in another way it's good to know that there's little changes you can make"

Rose, mother, P&BG

The responses obtained from the participants in regard to changes in practice to reduce exposure to harmful pollutants were varied and they mostly reflected the participants' personal project findings. For example, in the primary school project, children's air pollution awareness translated into different forms of action such as changing their routes to school and the adoption of active forms of transport (e.g. cycling, walking, scootering) (Varaden 2018). At the P&BG, SCG and COPDG the main changes reported included 1) opting for walking through back roads, along the river or canal paths, instead of busy streets, 2) walking instead of using the bus, at least for part of their journey, and 3) closing windows at home which face busy roads. An example of the narratives gathered from the P&BG participants in this regard is presented below.

"I try to walk more instead of taking a bus for a short ride. I will rather walk, I walked along the river, or I try to look for a road where there is less traffic and I walk. I avoid taking buses to places nearby, like the park, I go walking I don't need to take the bus. I avoid taking the bus unless it is extremely necessary or if I am going to a place far away. Small things like that" *Martha, mother, P&BG*

Participants from the SCG, also reported that as a result of participating in the project, they had tried to reduce their exposure to air pollution by making some changes to their normal routine such as starting to use the gas cooker extractor on regular basis and leaving the house outside rush hour, especially school pick up time, which they considered the busiest time. Some COPDG participants also reported avoiding going out during rush hour. For most SCG participants and some COPDG participants, it was possible to adjust their daily routine, given that most of them were already pensioners who did not have to attend work commitments and could use their time more freely. This, of course, was not possible for other participants who had to commute to work and, or, for parents and children whose times outside coincided with the busiest times of the day.

A few COPDG participants also said that they were trying to check the air pollution forecast more often through 'airText[4]'. This was the only group where people reported knowing about the air pollution alerts 'airText'. COPDG participants learnt about this tool during their rehabilitation-education sessions with the physiotherapists. Physiotherapists recommended making use of this tool to get information about air pollution episodes, so patients could adjust their outdoor activities accordingly. Despite many people reporting having heard about the airTeXT during their rehabilitation-education sessions, very few reported to be actively using it. Participants from the COPDG also reported to have found particularly useful the information obtained about air pollution exposure while driving. For example, Sam said:

> *"The airflow control in the car, wasn't working, but it's working now because I've fixed it, after we talked about the car last week. I've sorted it out and made sure that – under the bonnet it was jammed, and I never bothered. I thought, "I don't care about that." But now I do, because it's an airflow thing in there. So, you can, I can drive to here, out of town to the country, with the same air in my car. I mean I've got a van, so it's a camper van, so it's quite a big area, so I can go miles without bringing in any air into the car, which is a good thing"*
>
> *Sam, COPDG*

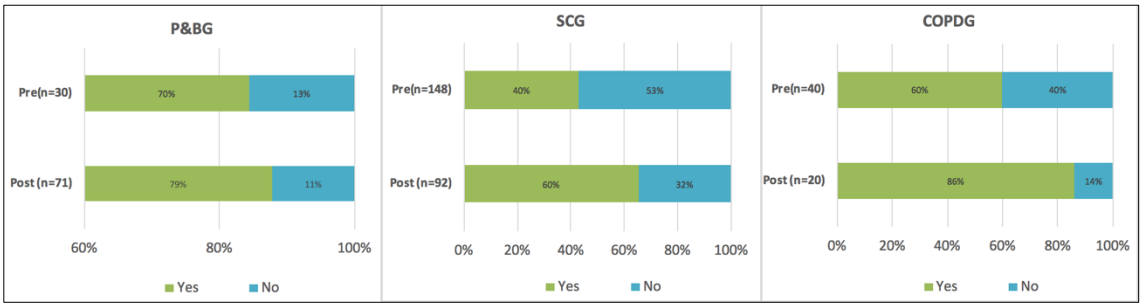
Most COPDG participants who normally drive, said they now close the car windows while setting the cabin air to recirculate when driving along busy roads or sitting in queuing traffic. Increased awareness of localised air pollution sources, such as those emitted from construction sites, were also reported by some COPDG participants:

[4] The airText is a free service which provides air quality alerts and health advice when air pollution is forecast to be moderate or high, using the UK Government's Daily Air Quality Index scale (CERC,2018).

"I've been on building sites all my life, I don't think about building and – but now, doing this, that has made me a bit more aware of building sites, keep away from them, I don't need to be going there"

Betty, COPDG

The views regarding 'changes in practices' of those members from the community groups that did not take an active role in the air pollution monitoring exercise was also studied. Members of the community groups were asked before and after the projects were undertaken "Do you think it is possible to reduce the amount of air pollution you are exposed to by changing your behaviour? Figure 6-5 below presents the responses obtained.



Question 8 - "Do you think it is possible to reduce the amount of air pollution you are exposed to by changing your behaviour?

Figure 6-5 Pre and post survey results

The data gathered from the surveys showed that, in general, there was an increase in the percentage of participants from all groups who, after the projects took place, felt that there were certain changes in their routines that they could adopt to reduce their exposure to air pollution. However, it is worth noting that given that participants from the P&BG attended the group meetings at irregular schedules, the data gathered from the first survey did not capture the views of all those who took part in the second survey, given that the number of respondents to the second survey was significantly higher compared to the first survey. It is also possible that many of the second survey respondents at the P&BG could have been unaware of the project and its results.

The main changes in practices reported by the participants were: walking/cycling through back streets and using public transport instead of driving. In general, senior citizens reported to be particularly inspired to change some of their practices to reduce exposure to harmful pollutants, highlighting that for them, as pensioners, was something easier to achieve as they had more control over the activities they do during the day (e.g. they could avoid the rush hour) compared to other people with fixed schedules.

As participants' own accounts suggest, the participatory approach followed during this study seems to have increased individuals' knowledge about air pollution and inspired them to adopt more proactive attitudes towards avoidance of pollutants. However, the reported findings are only short term and therefore, it is not possible to draw any conclusions about the long-term impact of this type of participatory intervention.

6.4.4 Influencing political choice and encouraging advocacy

Through conversations and interviews with COPDG participants I noticed that their increase in air pollution awareness had influenced some other aspects of their decision making. At the time when I was conducting the interviews with the COPDG, the elections for London Mayor were taking place. Therefore, the 'for whom to vote' was a topic of discussion among the COPDG members. Many participants stated that their candidate of choice would be the one that have a clear agenda for tackling air pollution, as they considered that this was a critical issue that needed to be addressed as a priority by the new Mayor. Remarks about this particular topic were only gathered from the COPDG, this could be a reflection of the situation that was taking place at the time (elections for the London Mayor) and which was heavily portrayed by the media. The following interview extract illustrates.

> *"Looking at some of the candidates on TV, for example, the two candidates from the Labour Party and the Tory Party, didn't seem to have – they mentioned it, but it was a kind of token gesture. They didn't have on very much about what they were specifically going to do about pollution. They seemed to kind of skim over it, but yet they knew it was important to have it, to address it, you know. And I've had to think very – I've had a lot of thoughts about that. What I did actually do, and I don't mind saying it, I did vote Green, just because of out of a sense of self-consciousness really, my own kind of integrity. I felt that the green strategy, what I saw of it, what little I saw of it, was better than the other two. So I felt more comfortable voting Green in that election. It felt more responsible for me, as a COPD patient, for example, to do that, largely because the other two main candidates hadn't really addressed it in any great detail that I felt I could trust, you know. But the Green Party, I felt I would be able to trust in more for tackling the issues, from the environmental concern".*
>
> *David, COPDG*

Many of the people I interviewed across all groups reported that participation in the project had stimulated a 'curiosity' in air pollution. Some participants reported to have started actively seeking information about their current local council's strategies for dealing with the issue, while others reported to have checked the air quality conditions of other cities where they have

families and friends. For example, local resident ‘Ben’ from the BLP reported to have investigated that in Westminster unnecessary vehicle idling is considered an offence which can result in an on-the-spot fine. Since then, Ben has been reporting idling vehicles, especially taxis, to the council, using the available official channels. Ben said that he was not sure whether the council would take any action towards the offenders, but he believed that it was important to report such behaviours so that the Council acknowledges that residents do see idling as a problem.

Mrs Roberts, from the P&BG, told about how she presented her data at a local council meeting where officials were discussing the recent developments in the area and to which residents were invited. She described telling council officials that she had taken part in an air pollution monitoring project that had shown high levels of air pollution levels on the main local roads and junctions. She was very concerned about the additional air pollution that new developments would bring, mostly linked to the increase in heavy traffic transporting building materials along the local roads. Mrs Roberts urged officials to re-think their plans while considering the air pollution impact on the local area. Although council officials pledged to take her comments into consideration, she was a bit sceptical of the real impact of her intervention at the meeting.

6.5 Dissemination

In line with the participatory ethos of this research, all community group participants were encouraged to disseminate the project’s findings and knowledge gained, as described in Chapter 3. In general, participants were enthusiastic about taking an active role in the monitoring project (e.g. deciding where and when to do the measurements) and the gathering of the data itself. However, for many (excluding participants from the Breathe London Project), the dissemination of the findings was rather passive, mostly limited to their inner circle of family and friends. Participants stated that they would prefer for me to disseminate the data findings to wider audiences, highlighting that they trusted I would use the data they collected appropriately and that I would disseminate it through the most effective channels.

The information (results) disseminated at each of the groups were taken from the reports given to each of the participants.

The following section reports on the forms of dissemination used, and the extent to which this dissemination process took place.

6.5.1 Dissemination to family and friends

Children, in general, said that they talked about the project with their immediate family, parents, brothers and sisters. Parents highlighted that teaching the children about air pollution

at school would also benefit them and their families, as children normally talk at home about what they did and what they learnt at school (Varaden et al., 2018).

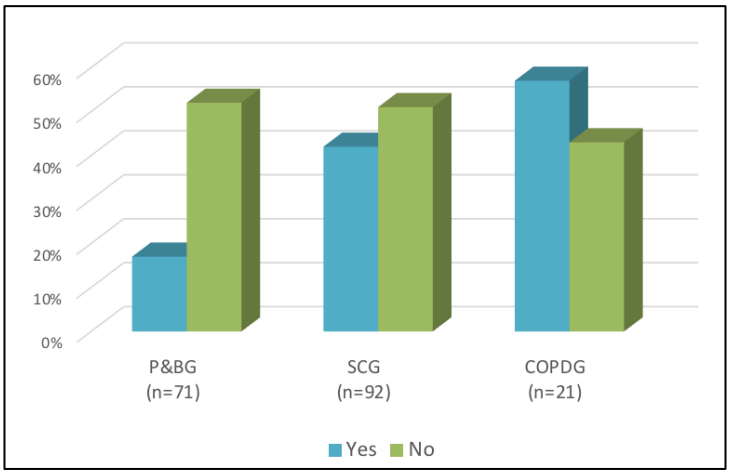
Participants from the SCG reported that their family and friends, especially those who live locally, were particularly interested in knowing about the technicalities of taking the measurements and the outcomes of the monitoring exercise. Some senior citizens highlighted that the knowledge acquired throughout the project, has given them the opportunity to initiate interesting conversations with family, friends and other members of the public around issues such as road and infrastructure developments and how those can affect the quality of the air, pollution inside cars and buses, the sources and location of air pollution hot spots, as well as alternative walking routes for reducing exposure.

Participants from the P&BG reported having talked to other parents, families and co-workers about the project and its findings, highlighting that "word-of-mouth" was a valuable and effective way for spreading out information. They also reported that the parents of young children were those who showed most interest towards the project findings and the advice to reduce exposure to air pollution.

In general, participants from the COPDG reported that many of their family members and friends showed interest in knowing about the project and its findings, especially about transport related sources of air pollution. However, some COPDG participants thought that their families and friends' interest in the subject was mostly driven by their desire to show support towards initiatives that could help reduce the worsening of the COPDG participants' health condition. COPDG participants also believed that for most of their young and healthy relatives and friends, reducing air pollution exposure was not much of a concern, as they did not perceive air pollution as an imminent risk to their health.

All of the individuals interviewed from the Breathe London Project (BLP) reported having shared their experiences of conducting the air pollution projects and the knowledge acquired with family and friends. Most BLP interviewees believed that, as a result of sharing this information, their families and friends were more aware of the dangers of air pollution and many were inspired to make changes in their practices to reduce their exposure. However, a small number argued that although some of their family members and friends seemed to be concerned about air pollution, there was not a genuine commitment to do anything to reduce their exposure.

The 2nd survey of community group members asked if they had spoken to any friends or family members about the air pollution project. The responses obtained from each of these groups are presented in Figure 6-6.



Question 9 - Did you speak to any friends or family about the air pollution project?

Figure 6-6 Post survey results

Survey results indicate that the highest proportion of individuals who had engaged into conversations about the air pollution monitoring project with family and friends were those from the COPDG (57%), followed by the SCG (42%), and the P&BG (17%). Some of the surveys' findings correlate with the information gathered through interviews and during informal conversations. For instance, COPDG participants highlighted that, in general, their family/friends were very sympathetic to their health condition. Therefore, they were interested in knowing about how their friend's/relative's disease could be managed more efficiently (e.g. reducing air pollution exposure). The results from the senior citizens group showed that while many participants shared the information gathered with family and friends, a similar number did not. This could be down to a personal desire to establish conversations about the topic. For example, when I asked Kiran if he had shared the data or the information obtained from this project with anyone, family and or friends, he replied:

"I didn't – I probably mentioned the fact that I'd done it to some people and possibly those anomalous things. It's not something I've, you know, brought up as something to discuss with people particularly". *Kiran, SCG*

The survey responses from the P&BG were in line with the some of the data from interviews and informal conversations with this group. Participants highlighted that their busy life style was a barrier for conveying information to other people, and or for changing practices to reduce exposure to harmful pollutants. Most individuals across all groups who reported speaking to family and friends about the project, said they had done so because they felt that their friends and relatives also needed to be aware of the causes and consequences of the air pollution problem. The particular interest in the subject could have been a reflection of the

construction-related developments taking place at the time when I was conducting the fieldwork at the P&BG and which increased the traffic volumes in their area.

6.5.2 Dissemination to larger groups

The primary school children were eager to present their findings themselves, and so with the help of the deputy Head, we arranged for an assembly to take place where the monitoring team shared their findings to the rest of the school during an assembly using a PowerPoint presentation (Figure 6-7, right). All participants from the SCG agreed to share their findings with the rest of the group, however, they said that they would prefer if it was me steering the talk (Figure 6-7, left).

Figure 6-7 Dissemination sessions SSG

Similarly, at the P&BG, all participants agreed to share their findings, although, as with the SCG they asked me to present their findings myself. However, since the projects' introductory session at the P&BG was rather challenging given the settings (e.g. noisy environment), I decided that for the dissemination session, it would be better to produce leaflets and poster which could be displayed in the community hall where they normally meet (Figure 6-8).

Figure 6-8 Poster display P&BG

By using this approach, P&BG members were able to access the information in their own time, while having the opportunity of asking me any questions. At the COPDG the results were presented to each of the rehabilitation groups by the physiotherapist, with my support, as part of their air pollution session.

Participants from all groups highlighted the value of seeing other people's findings as well as their own, as they could see what the air pollution was like in areas which they normally frequented but that they were not able to visit while carrying out the air pollution monitoring. Some participants from the P&BG stated that, although they considered air pollution to be a complex subject which can be sometimes difficult to understand for many, initiatives such as this could be valuable tools for communicating the subject to the public. However, they argued that if the information and advice received were to have a long-lasting impact, it was essential to present the community with local evidence (personal exposure data examples) on regular basis.

It was reported by some of the senior citizens that since the project took place and the results were presented to the whole group, air pollution became a topic that often came up in their informal talks. They believed that the project had not only benefited those who carried out the air pollution monitoring, but it also had a positive impact on those who had access to the findings. A summary of the findings of the air pollution monitoring project at the SCG were published by the group leaders in their monthly newsletter (Appendix H).

The wider and long-term impact of the findings obtained from the monitoring exercise carried out by the COPDG participants were highlighted by Sean, (COPDG physiotherapist) during his interview and by his colleagues through informal conversations. They stated that although COPDG patients are encouraged to get active and to 'walk around their local area', not enough consideration has been placed in advising them to avoid highly polluted areas (e.g. major roads). Physiotherapists agreed that it would be valuable to incorporate the findings from this study to their education sessions with current and future COPD rehabilitation groups. They said that the maps and graphs produced from the project findings would be useful for providing COPD patients with illustrative and real examples of the sources of air pollution and the areas in their neighbourhood where pollution was worse. This approach for delivering advice and information about air pollution to vulnerable groups can be valuable as it is likely that individuals will be more willing to receive and accept the message if it comes from a trustworthy messenger, in this case, if the message comes from their health practitioner.

The results presented at each of the groups were examples of the most interesting findings of all the data gathered by the participants, with the exception of the primary school, where children wanted to present all their results.

Participants from the Breathe London projects used a number of channels at their disposal for disseminating the findings. Louis, a journalist, prepared a news report based on his experience of carrying out the air pollution monitoring and the data findings. Daniel, Lila and Lawrence from Crossrail and Charlotte from Investec used their data findings to support awareness campaigns within their company. Daniel, the Crossrail project coordinator said that he had received positive feedback from people that were not part of the project but who learned about it through internal emails and newsletters. Daniel commented that he received numerous emails from employees asking for more information as they were very interested in the topic. Project coordinators Gloria from the "close the door study" and Lara from "Open streets" used the data gathered to advocate for cleaner air to council officials and central government through pressure groups and social media channels. Local residents who were also project coordinators such as Margaret from "the Dog Hill primary school study", not only used this data to lobby local council officials for better environmental conditions, but also to raise awareness among local residents, particularly children through innovative channels. Margaret designed a cartoon character called "Minty the green dog" to communicate her project findings (Appendix I).

6.6 Discussion

The purpose of this chapter was not to suggest that a participatory research approach is the only or best way for communicating air pollution as a health risk across communities. Rather, the objective was to report on the experiences of those who took part in the process, with an ultimate goal of shedding some light on the feasibility and effectiveness of using this approach for engaging the public into air pollution discussions.

The participatory research approach used throughout this study gave participants the opportunity to be part of the research process. This included aspects of the air pollution monitoring design, where participants chose the routes to be monitored, interpretation of the data, where participants identified air pollution hot spots on the maps provided and helped contextualise the findings and dissemination of the results, where participants (monitoring teams) shared the findings with other members of the community groups (e.g. through newsletters - senior citizen group) or used the findings to complement already established air pollution awareness initiatives (COPD physiotherapists).

It was identified that the main reasons why members of the public took part in this participatory research intervention were in line with those previously identified in the literature: personal interest in the studied subject, desire to learn, and concern for the greater good (e.g. future generations) (Rotman et al., 2014, Land-Zandstra et al., 2016, McCrory et al., 2017). However, I argued that those reasons are driven by participants' personal circumstances. (e.g. parents of

young children, pensioners, individuals with chronic illnesses etc.,). This can make the engagement process more challenging, as engagement strategies have to be constantly tailored to specific individuals and, or circumstances. While gathering knowledge was reported to be the most common reason for participants to get involved in this study, I argued that people were seeking different types of knowledge, which they wanted to use in different ways and for different purposes. There was 'knowledge to safeguard future generations', this type of knowledge was commonly desired by some of the senior citizens and by the parents of young children, who wanted to protect their grandchildren/children from the harmful effects of air pollutants. 'knowledge to safeguard self', characteristic of most COPDG participants who wanted to know more about potential sources that could exacerbate their symptoms. There was also 'knowledge to assess the local magnitude of the problem' and 'knowledge to build evidence to advocate for change', the latter was mainly pursued by environmental campaigners and community leaders, who were eager to learn more about the subject and to gather evidence-based data of the presence and levels of harmful pollutants in their neighbourhoods, in order to show regulators who had the power to make policy changes. Finally, there was a type of knowledge which I called 'knowledge in it is own right' commonly pursued by those participants whose social contexts involved a learning environment (e.g. school children and senior citizens members of the U3A).

The air quality data collected during this study was mostly from the participants' local area. This made the findings from the monitoring measurements relevant to the participant's daily lives such as places they visit (church, hospitals, recreational places, etc.) and the different routes and modes of transport they take to get to those places. This allowed for a contextualisation of the presence of harmful pollutants in their local surroundings (Beaumont et al., 1999). Having information about air pollution and access to personalised self-collected air pollution measurements appeared to have increased participants' awareness and understanding of air pollution causes and health effects.

Furthermore, the findings from this study suggest that by taking an active role in the research process, individuals were inspired to not only reduce their own air pollution exposure but also to think about ways in which they could reduce their own contribution to the problem as well as how they could influence other people's practices in order to reduce their exposure and contributions. While awareness of the problem lead participants, in general, to take some sort of action to act upon, it was observed that this was not always a linear and/or immediate process and that participants assimilated and acted upon the information received in different ways and through different channels. For example, for some participants particularly those from the COPD group, the actions adopted were at an individual level, trying to identify and

adopt active ways to move around their neighbourhoods (e.g. walking, cycling etc) while avoiding busy roads. The school children came together as a group to proposed anti-idling campaigns around the school, aiming at influencing parents' drop off and pick up practices". Senior citizens on the other hand were eager to raise awareness and to stimulate changes in practices by sharing the findings of the study with other community members through internal communications channels (groups newsletters).

While the air pollution monitoring was only carried out by a subset of people from each of the community groups, their findings and experiences of taking part were reported to have been disseminated among their family, friends and other members of their community groups. In general, the dissemination process was reported to be effective using word-of-mouth as a communication tool for disseminating information. However, while most participants across all groups wanted to share their findings with the rest of the members of their community groups, in many instances, the extent to which they got involved in the dissemination process was rather passive. Therefore, my support to convey the findings from the study to the rest of the group members was required.

Throughout this project, I observed that participation in the air pollution project had different outcomes at each of the community groups. The primary school children seemed to have been the most enthusiastic ones. They were eager to learn, disseminate the findings with family and friends and implement actions to try and remediate the issue. Participants from the P&BG, on the other hand, although very interested in the subject, particularly on how air pollution can affect their children, showed very little interest in using the information obtained through the project for anything other than their own benefit and that of their children. Similarly, participants from the COPDG, who were noted to be the most knowledgeable in the subject, seemed to have used the project findings for further understanding and addressing their own personal exposure to harmful pollutants. The senior citizen group, the most dedicated group seemed to have used the experience of taking part in the project as a learning and stimulating exercise, which findings they considered important for safeguarding the health of future generations. The BLP participants, in line with their activist nature, were characteristically eager to advocate for action.

In order to explore further the potential of using participatory research approaches for engaging communities into air pollution issues, in the following chapter, I will explore the views of those who took part in this study in regard to their understanding of the air pollution problem and the way they perceive the risk posed by air pollution as a result of taking part in this project.

Chapter 7 - Results: Risk perception and communication

Introduction

In the previous chapter, I described how a participatory research approach was applied to this study and I reported on the experiences of people from diverse community groups across London who took part in that process. In this chapter, I will focus on exploring people's understandings of the risks posed by air pollution, the nature of the risks, its effects and whether or not people think that air pollution can harm them. I argue that, risks are not merely fixed and calculable as it would be suggested by a positivist approach to risk but are also the product of social contexts and people's understandings. In this chapter, I argue that while air quality monitoring calculates measurable variables that can be used to calculate the 'risk' of harm through exposure, sociological perspectives on risk such as 'cultural theory' assume that risk is a cultural category that may be understood in different ways by different actors.

The chapter begins by defining risk and exploring some important sociological contributions to risk research which I have used as a framework to consider my results. I then considered my research findings in light of Ulrich Beck's concept of 'risk society' (1992). The risk society concept argues that as modernisation generates technological changes, it also produces new forms of risk to which people are constantly required to respond and adjust (Beck, 1992). Our society has not only seen an increase in industrial progress (e.g. industrial revolution and associated global demands for fossil fuels) but has also seen an increase in hazards (e.g. air pollution). These hazards are considered to be the consequence of human activity and have led to events which are threatening human existence itself, (e.g. chemical exposures, nuclear contamination, climate change). I conclude this chapter by discussing how understanding and addressing people's perceptions of the risks posed by air pollution are important for developing effective and engaging ways for communicating air pollution as a health risk to the general public.

7.1 Risk

Risk is a contested category, with little consensus about how to define it. Some definitions focus on the likelihood of bad events occurring, while others focus on the magnitude of the consequences of those events.

Since there is not an official single definition of risk, I will use this definition:
"Risk:
A situation involving exposure to danger (noun)
Expose (Someone or something valued) to danger, harm or loss (verb)"
(Oxford Englhish Dictionary Online, 2018)

Risk can mean different things depending on the discipline in which the concept is being explored (Lupton, 1993). Engineering and occupational health disciplines focus on hazard and risk identification (explicit knowledge), psychology studies how risk is managed at a personal level focusing on risk perceptions (individual knowledge) (Berg-Beckhoff et al., 2017, Slovic, 1987), and sociology perspectives on risk, which, in general, look at how people understand and respond to uncertainty and misfortune (social knowledge) (Lidskog and Sundqvist, 2012). While natural science disciplines typically use probabilistic approaches to defining risk mathematically, social science disciplines tend to evaluate humans' understanding of different risk representations (Berg-Beckhoff et al., 2017), emphasising that risks are always situated in a social context and are connected to actors' activities. (Lidskog and Sundqvist, 2012).

7.1.1 Theoretical approaches to risk

From the epistemological point of view, there are significant differences in the way risk is conceptualised across different disciplines. From positivist perspectives, risk is considered to be a phenomenon of the physical world that can be measured and calculated. In contrast, according to constructivist perspectives, representations of risk are only the result of human understanding, how we perceive and interpret a particular phenomenon (Mercantini and Faucher, 2015). Within the field of sociology, I considered two important contributions to risk research, which I now briefly outline.

<u>Cultural Theory</u>

This approach was developed by Mary Douglas alongside her colleague Aaron Wildavsky (Douglas and Wildavsky, 1983). They argued that cultural adherence is a key factor that determines how people understand and perceive risk. Thus, people's views are shaped by the nature of their social group, and they conform with their way of life. Furthermore, it has been suggested the cultural theory of risk is capable of "predicting and explaining what kind of people will perceive which potential hazards to be how dangerous" (Wildavsky and Dake, 1990). Cultural theory assumes that people perceive risk through a cultural 'filter', which influences the information that people receive and the way the risk is perceived and as a result, it influences how people respond to it. Cultural theory considers that people's attitudes

towards risk are ultimately culturally dependent and it sees people as active constructors of risk understandings rather than passive receivers of risk information (Rayner, 1992).

According to the cultural theory of risk, there are two dimensions in which social participation can be adequately characterised: 'group' and 'grid'. Group refers to the extent to which an individual is a member of a socially bonded unit and how the dynamics of the group influence the individual's 'worldviews' (*weak bonds between people: fatalistic, individualistic, strong bonds between people: hierarchic and egalitarian*). Grid refers to the internal structure and how social roles are positioned (*stable and regulated or uncertainty and change*) (Douglas and Wildavsky, 1983). This model has been used as a classification system where people's awareness of certain types of danger are in line with specific ways of life. In South Korea, for example, cultural theory of risk was used to examine how cultural 'worldviews' influence the way people interpret risk in the context of particulate air pollution (Kim HK and Kim Y, 2018). This South Korean study collected data using an online survey, where the four 'cultural worldwide dimensions' were assessed based on cultural biased questionnaires. The authors argued that the extent to which people seek information and the way people process this information, is determined by their cultural 'worldviews' (Kim HK and Kim Y, 2018).
Cultural theory has also been used to contextualise people's understandings and responses to climate change in places which are greatly affected by climate change impacts and policies (McNeeley and Lazrus, 2014). In this study, the authors argued that cultural theory was a useful framework to understand people's cultural perceptions of social organizations and nature. This, they argued, helped them to identify social barriers to climate change adaptation (e.g. disconnects between cultural views of nature and management practices) and to assist communication between those actors involved (McNeeley and Lazrus, 2014).

Critics of cultural theory argue that this conceptual framework can be somewhat simplistic, where social-risk perception is limited to the categories of cultural bias used, (Boholm,1996). However, despite its weaknesses, cultural theory offers a useful way of thinking about how risk and risk responses can be influenced by socio-cultural factors. This is particularly important in this study since the participants views and perceptions that I will be exploring are from individuals who belong to various community groups (socio-cultural contexts), Furthermore, I argue that while air quality monitoring calculates measurable variables that can be used to calculate the 'risk' of harm through exposure, sociological perspectives on risk such as cultural theory (Douglas and Wildavsky, 1983) assume that risk is a cultural category situated in a social context which may be understood in different ways by different actors.

Risk Society

The concept of risk society was first used by German sociologist Beck Ulrich (Beck, 1992) and later by English sociologist Anthony Giddens (Giddens, 1999). Both authors argue that humans have always been exposed to natural disasters, events that have put their lives and wellbeing at risk of harm. However, they highlighted that these 'events' (e.g. flooding, earthquakes, hurricanes) are outside people's control and they are caused by external 'non-human forces. Modern society, however, is now exposed to a different kind of risk defined this as 'external and manufactured risk'. This new type of risk is the result of human activity e.g. war, chemical pollution and climate change. Beck argues that humanity has moved from a situation where certain harmful effects from industrialisation were a manageable price to pay for modernisation, to a situation where technological advances have led to events which are threatening human existence itself, e.g. chemical exposures, nuclear contamination and climate change.

In risk society, the risks produced are no longer seen as affecting limited localities or social groups. On the contrary, risks are considered to be 'universal', that is, they do not discriminate between social class or social wealth. Risks therefore have global, not merely personal consequences. This is argument is not only related to negative consequences (e.g. damage that an environmental disaster can cause to human and wild life), but also the global positive consequences that the aftermath of a risk event could bring. For example, the occurrence of incidents such as the Bhopal disaster in 1984, considered to be the world's worst industrial accident in history, highlighted the need for enforceable international standards for environmental safety (Broughton, 2005). Similarly, nuclear disasters such as in Chernobyl in 1986, have intensified the debate and concern about the safety of nuclear plants (Irwin et al., 2000). Effectively, humans can reflect upon the past and use this knowledge to influence what they do in the future (Giddens, 1999). This is what Beck and Giddens presented as the notion of 'reflexive modernisation', which they argued is an increase of awareness and reflection: as society becomes self-critical it changes itself in the process (Beck et al., 1994). Beck argues that in order for societies to evolve, modernisation must become 'reflexive' (Beck, 1992). The idea of reflexive modernisation also leads essentially to a critical change of social structures where individuals can take their own decisions without any reference to political, economic and socio-cultural factors. One key element in reflexive modernisation is the rise of significant new questions about institutional trust whereby society questions the ability of institutions to understand and handle the risks (Lidskog and Sundqvist, 2012).

During fieldwork and later while analysing the qualitative data, it became apparent that sociological notions of risk such as risk society (Beck, 1992) could provide a useful framework

to consider my results. Therefore, drawing on these above notions of risk society, I will now present and discuss the perceptions and attitudes towards air pollution reported by the individuals who took part in this study. I will discuss how air pollution has become a manmade risk without delimitations of space (localities) and time (short term health effects/long term health effects).

7.2 The invisible killer

> *"I went to a conference somewhere and when I came out, the sky was orangey "beautiful!" Then someone told me that it was air pollution, I couldn't believe it. It was there, I could see it! the pollution from the factories nearby.*
>
> *Participant, SCG*

While some study participants reported having "seen" air pollution such as the senior citizen quoted above, unlike the infamous smog in 1950s London, for most of us, modern air pollution remains essentially invisible. Furthermore, for most people, air pollution is not only invisible, it is also odourless and tasteless. The theory of risk society emphasises that most modern risks emerge from the modernity in which we live, they are mostly of invisible nature, and in order to reveal them, sophisticated technical equipment is needed (Beck, 1992). This is mostly true for the risk posed by air pollution, which has become a harsh consequence of industrial growth and which existence is generally only verified by experts using appropriate technical monitoring equipment.

During this study, participants placed particular attention to the power of vision. Some of them commented on their experiences of "seeing" air pollution, in the form of smoke and fumes emitted by specific sources such as car exhaust. Other participants, who did not report having any direct experiences of "seeing" air pollution, alleged that accepting that air pollution was present was more of an act of "faith". The following interview extract illustrates.

> *"I think the link between smoking and lung cancer and emphysema and so on was clearly demonstrable. Smoking, you can see smoke, you can taste it, you can breathe it in. Air pollution is a silent thing, it's invisible. And it's more like a religious act of faith to believe that what we're breathing in now, this air we're breathing has carbon in it, albeit a very small amount, and if we go down the main road, we'll breathe it in, and we don't feel any different. And we don't have that kind of obvious link between the two".*
>
> *Mr Woods, SCG*

Study participants also argued that the invisible nature of air pollution had prevented Londoners from seeing the magnitude of the air pollution problem in the capital. Instead, they became complacent to the way London actually is and they learned to accept it with its traffic jams, high levels of air pollution and housing shortage. However, participants highlighted that if the right tools to help people "see" the air pollution were available, people would view their surroundings through different lenses and other senses to perceive air pollution such as "smell" would also start to awaken.

Remarks about being able to "see air pollution" were often accompanied with remarks about "smelling air pollution", especially from some of the primary school children, who noted that although they could not "see" air pollution, they knew it was there because they could "smell" it particularly when standing or walking along busy roads. Statements about what participants could not "see" before the air pollution project and what they could "see" after the project took place, were common and expressed with conviction. The following extracts from the COPDG illustrate people's narratives regarding the power of vision.

> *"Well, before, it was invisible. And so the variability of my condition, I didn't know what was going on and becoming anxious, stressed, depressed and unable to breathe and not knowing why. And trying to look for other factors as to why it could be. So this was a real revelation for me to know that, "Ah, there's another contributing factor that is unseen, that is invisible. And that explains all the things that I've been to the doctors for the last year or two." Because, this had been going on for me for a long time, trying to work out why I was having these breathing difficulties prior to the COPD diagnosis. And even after the COPD diagnosis, these triggers were still going on until I did this study, which seemed to change my perspective and give me a different bearing on – well it made it more visible, that's what I'd like to say. So, by looking at that data and those graphs and being part of that study, it's made something invisible more visible to me, if you like, cognitively. So I now have a cognitive level, I can make decisions around. Okay, I know I can't see it. I know there are exhaust fumes and emissions coming from the back of that ice cream van. And so, I should avoid ice cream vans. I mention ice cream vans because, in my observations, I notice ice cream vans leave the engine switched on and there's lots and lots of fumes around ice cream vans".*
>
> *David, COPDG*

> *You don't realise how much air pollution there is until you actually do a survey. Most times, before this, you just think, "Oh I'm just out of breath." But then, when I did the*

survey, I thought, "No it's right," you know, you've got to be aware of where you're walking because there is pollution everywhere, whether it be a little bit or a lot. But, with my condition, it will affect me.

Laura, COPDG

The above statements seem to indicate that COPD participants believed that their newly acquired ability to 'see' air pollution had helped them make connections between instances where they felt unwell (e.g. short of breath) and potential presence of harmful pollutants. It is important to highlight that it is not possible to determine whether the reported experiences were a perceived association or an actual association. Having a certain degree of control over the source of pollution (e.g. being able to identify it and, therefore, avoid it) seems to influence the way people perceive, respond and manage the risk of air pollution (Gatersleben and Uzzell, 2000).

7.3 How does air pollution affects my health?

According to the cultural theory of risk, awareness of risk can be largely influenced by how much we know about the topic in question and by the kind of people we are (Douglas and Wildavsky, 1983). The qualitative data gathered during fieldwork with various community groups across London illustrates the diversity of perspectives and attitudes towards risk among the general public.

For several of the study participants, air pollution is accountable for a number of health issues, such as asthma attacks, headaches, dizziness, coughs and allergies. Statements about how air pollution was responsible for a number of health issues, were expressed with conviction mostly by parents of young children. For example, one mother claimed that she was certain that air pollution was the cause of her daughter's skin allergy as this was the diagnosis given by her own GP. Parents also argued that their children and some of their friends' children developed respiratory problems since they moved into the neighbourhood, which they considered to be a more polluted area.

"I'd been speaking to a couple of my neighbours and they talked to me and they said, that since they moved to this area their children… they got an increase in their asthma, and their lungs weren't functioning as well as they used to, so they were out of breath a lot of quicker. She said it was definitely down to the pollution that we've been getting in this area and this road is so busy and I'd been talking to my husband about it and he said yes, it is polluted but you don't know how much".

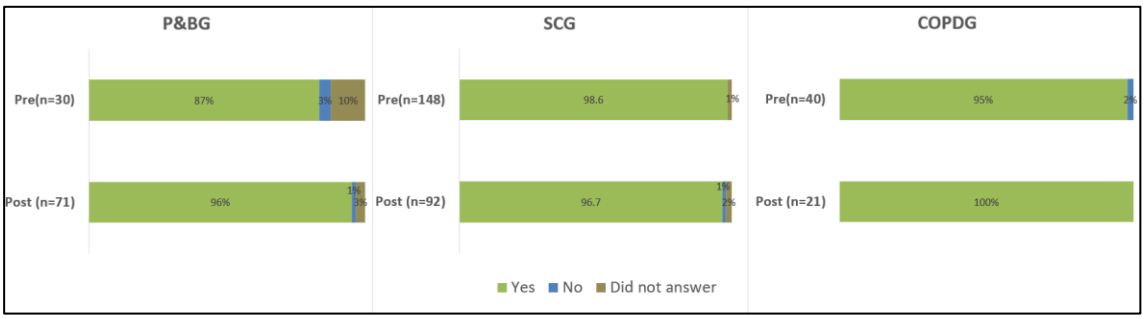
Dora, P&BG

The parents' remarks about the impact that air pollution can have on the health of their children and their friends' children, indicate that participants perceived the risk posed by air pollution not only at a personal level but also at a community level. This perceived awareness of the dangers of air pollution on other members of the community, was also observed from Bianca's (Aleena's mum-primary school project) remarks. Bianca with some hesitation, told me that she was diagnosed with breast cancer a year ago. She alleged that "coincidentally" around the same time, her neighbour was also diagnosed with breast cancer. She strongly believed that air pollution was the cause. She argued that before she and her neighbour moved to London, they were absolutely healthy. For Bianca, the perceived association between air pollution and her cancer was made stronger by the fact that the "cancer" did not only happen to her, but also to her neighbour, someone who lives on the same street, had the same age and whose everyday life was similar to Bianca's.

Many study participants from the primary school, parent and baby group and senior citizens group, were inclined to promptly link environmental factors (air pollution) to numerous health problems. However, most respondents did not mention the possible links between lifestyle risk factors (e.g. exercise, smoking, diet and obesity) or genetic predisposition and health. In contrast, most of the COPDG participants reported that the main cause of their disease was down to lifestyle factors particularly, "tobacco smoking" and "work environment (e.g. construction)". In general, COPD participants believed that despite the initial cause of their health problems, air pollution was without doubt a trigger for the worsening of their condition. However, it has been reported that there is no clear evidence of the link between air pollutants and COPD exacerbation (Moore et al., 2016). Most of the COPDG participants claimed that even though, they could not "see" air pollution, they could 'feel' it. Many participants reported feeling unwell (e.g. shortness of breath, chest tightness and chronic cough) almost immediately after visiting areas which they believed to be highly polluted (e.g. areas with heavy traffic), particularly if it was a hot day. The extract below illustrates.

> *"It was such a hot, hot day and with the fumes, it was absolutely unbearable. I had to get in a taxi to where I was going. It was only around the corner, you know, it wasn't that long. But I had to get in a taxi because I couldn't breathe."*
>
> *Cristina, COPDG*

To assess what other members of the community groups (individuals who did not take part in the air pollution monitoring) thought about the link between air pollution and people's health, the surveys I conducted incorporated one specific question "Do you think air pollution affects people's health? If yes, in what ways?". Figure 7-2 below presents the results from the survey.



Question 6 - Do you think air pollution affects people's health?

Figure 7-1 Pre and post survey results

Participants responses before the project took place (pre-surveys) showed that most participants believed that exposure to air pollution negatively affected their health. This may suggest that there was certain level of awareness about the health impacts of air pollution, among individuals from these community groups, even before taking part in the air pollution projects. Respondents identified asthma, COPD and bronchitis as the main health problems likely to be associated with air pollution. Participants across all groups also noted that air pollution can affect the normal development of the brain and the lungs of young children. It was also reported, although to a lesser extent, that problems such as skin and eye irritations, dementia, circulatory problems and depression could also be attributed to air pollution exposure.

7.4 Is London really the most polluted city in the world?

Despite London's bad reputation for air pollution, according to a report by the World Health Organisation based on urban air quality data – annual means for $PM_{2.5}$ and PM_{10} values, London its ranked as the 940th worst polluted city in the world out of 1622 (World Health Organization, 2016). The majority of the world's most polluted cities are in developing nations such as India, China, Iran and Pakistan.

By involving a variety of community groups from different areas of London, I was able to gather information from a range of participants from various backgrounds and nationalities. Participants from countries such as India, Pakistan and China expressed the view that the air pollution problem in London was "nothing" compared to the current situation faced by their countries of origin. Some participants noted that when they go back to their home countries to visit relatives they can "feel" how "dirty" the air is and that they appreciated how clean the air was in London. An example of this is COPDG participant Ed, who highlighted that in London, he can go everywhere around the city, even to places where there is a lot of traffic and his health condition (COPD) does not seem to be affected by his exposure to air pollutants. However, he claimed that as soon as he lands in his city Hong Kong, he starts feeling very

unwell, struggling to breathe and coughing vigorously. Ed commented that when he is in Hong Kong, he spends most of his time at home with relatives and he avoids going outside even for short periods of time.

> *"In the street you won't feel it in London. In Hong Kong, I come from Hong Kong, I just can't breathe at all. Sometimes if you go to China it is just horrible".*
>
> *Ed, COPDG*

It is well known that air pollution is a major health issue in China, and smog is increasingly frequent and severe in many cities. (Kan et al., 2009). For some participants, moving to London was like "escaping" from air pollution, such as a woman from the P&BG who claimed that one of the reasons for her to leave her country of origin (China) and move to London, was in part to get away from the air pollution. She wanted to offer her children a better environment where to live. Similarly, for some senior citizens, the severity of the air pollution problem in London was overstated. They highlighted that in 1952 the dramatic thick smog was very tangible, so it was evident that something was in the air.

Participants' scepticism about the severity of the risk posed by air pollution in London, mostly driven by the "invisible" nature of the problem, highlights some of the challenges likely to be encountered when trying to communicate air pollution as a public health risk.

7.5 Air pollution: how bad and how big is the risk?

> *"Before I'd been talking to my neighbour, I had the opinion that if you were around lots of pollution it just makes your lungs stronger and it makes your immune system stronger, but it is actually the opposite when I started looking into it".*
>
> *Dora, P&BG*

In this section, I discuss how participants responded to the air pollution information gathered, including what participants said about the air pollution levels identified and the nature of the risk this presented.

7.5.1 Calibrating the perceived risk

When interpreting the air pollution monitoring results, participants paid close attention to the highest levels of pollutant Black Carbon (BC) recorded, and often asked whether these levels were 'safe'. Participants wanted more than a descriptive account of their findings, they wanted to be able to compare their results to government health-based guidelines, so they could assess whether their results were cause for concern.

The first feedback report I handed out after the primary school project, was to Isabel from the P&BG. Isabel's report contained graphs showing the times and levels of black carbon measured, and maps showing where about were those levels recorded. Given that BC is a pollutant for which neither a safe level nor a toxic threshold has been identified yet, I had to present the project findings to participants, using relative comparisons in the context of what we could do to reduce their air pollution exposure based on precautionary principles (Jeong and Park, 2017). However, for Isabel something was missing: she highlighted that the information contained in her report alone was not sufficiently informative as she did not have anything to compare it with. She argued "I want to know what is high and what is low! So, I know where I am". Isabel asked if she could see the other participants' data (e.g. their average exposure to BC at home, commuting, at the park etc). She claimed that this would give her an indication of how "bad" or "good" were her air pollution exposure levels, compared to those levels recorded by other people who live in the same neighbourhood. Following Isabel's feedback, I prepared a table (Figure 7.2), where the average BC exposure for each of the activities reported by the participants was presented.

Parent & Baby group participants	Average levels of black carbon (µg/m^3)			
	Home	Walk	Bus	Car
A	1.4	3.8	-	2.0
B	1.8	4.4	5.2	-
C	1.1	3.6	-	-
D	1.1	3.1	-	-
E	1.0	3.5	5.9	-
F	1.6		-	
H	1.3	1.8	-	
I	1.8	3.7	-	-
J	2.2	2.9	-	2.6
K	3.7		-	4.4
L	-	4.3	-	5.4
M	1.6	6.0	5.0	

Figure 7-2 Example of group exposure results given to participants as part of their project data results

A table like the one above was added to each of the feedback reports for all the participants across all groups. Given the lack of regulatory benchmarks/safe limits for the pollutant measured (black carbon), participants based their interpretations of the findings on comparisons between their measurements and those of others. In general, study participants did not seem particularly concerned when their mean exposure results appeared "in the middle" or "below the middle". However, participants seemed to be worried if their mean

exposure results were above the "middle" of those measured by other participants, especially if the high levels recorded were from their own homes.

Air pollution is considered to be the largest environmental risk to public health in the UK (Public Health England, 2018). Personal exposure to harmful pollutants occurs in both indoor and outside environments (Laumbach et al., 2015). As part of the air pollution monitoring, most participants (excluding primary school participants, who carried the monitor just for the school trips) had the opportunity to measure the levels of air pollution (BC) in their own homes. Some of the air pollution data gathered from the participants' homes showed the presence of high levels of air pollution at various times during the day. Most of these high readings were correlated with reported activity diary entries, such as cooking or smoking, while others were more difficult to understand. The air pollution levels recorded in the participants' home, were always a matter of great concern as participants felt that harmful pollutants were trespassing the boundaries of "safe" personal space. The following example illustrates this.

Tim, a participant from the P&BG and father of an 18-month-old baby who suffers from cystic fibrosis, was particularly concerned with the levels of BC recorded inside his home. Tim's results showed that BC levels were at times and without obvious explanation higher than those levels recorded outside. Tim assured me that the indoor source was very unlikely to be the result of cooking activities or burning scented candles, both of which have been identified as common causes of indoor air pollution (LaRosa et al., 2002). Due to Tim's baby's ill health, he felt it was important that his house was 'safe' from harmful pollutants which could aggravate the baby's condition "This is important for us, we need to take care of his lungs!". Tim was determined to identify the source of pollution inside his home.

Tim conducted the air pollution monitoring inside his home again. This time I advised him to leave the instrument on at home for 48 hours (same place as the first experiment). The levels recorded on the first day of the second experiment were very much like the concentrations recorded at most of the other participants' homes. On the second day of the second experiment, the concentrations were slightly higher than the first day. Visual observations of the plotted result made me think that on the day of the first experiment the source was likely to have originated inside the house (plotted line high and spikey), and on the day of the second experiment the source was likely to have originated outside of the house (plotted line smooth with a long decay). To further investigate the origin of the air pollution present inside Tim's home, we looked at the surroundings. We found a metal forge at about 85 metres northwest of Tim's home. Metal factories can produce a huge amount of dust, for example when grinding. They may also have a forge, dependent on whether they just do welding or not. Tim said he

had not noticed anything such as smoke or similar coming out of the chimney. I did stress that the factory was a possible source, but that it may be completely innocent. I did not want to raise alarm or sensitivity over something that I did not have strong evidence for. For the same reason, I made sure I pointed out several times that we had only detected significant peaks inside his home only once and that there was no need to be alarmed. Tim appeared to be reassured to know that the unknown emission was recorded just once, and he pledged to implement all possible measures (e.g. turning extractor on when cooking, closing windows that faced major roads etc) to reduce air pollution inside his home. While monitoring practices such as the one undertaken can offer the opportunity to identify and provide evidence of risk, they could also leave those engaged in the process without clear action of how to act upon the evidence fund (Gabrys, 2017). For Tim, as for many of the participants, a descriptive account of the data gathered was not enough. He was eager to find the source of the problem as he wanted to address the issue.

7.5.2 Ranking the risk

It has been argued that people's perceptions of risk are determined by social and cultural factors (Douglas, 1983). However, it is unlikely that cultural theory would be able to predict risks perceptions in specific situations. For example, during this study, parents from the primary school project highlighted that although they agreed that air pollution can affect their children's health, they also felt that priority should be given to other risks, which they perceived as more "imminent", such as road safety (Varaden et al., 2018). Contrary to my concerns about exposure to polluted air, people were inclined to give more importance to other more immediate risks.

Furthermore, the qualitative data gathered also suggest that participants were able to rank hazards and decide how to act upon them. For example, the highest levels of air pollution recorded by Mrs Roberts, mother and gatekeeper from the P&BG, were when crossing a very busy junction during drop off and pick up times from school. The way the traffic lights were set up at this junction meant that people were only able to cross one set of lanes at a time, having two waits approximately two minutes before they could cross the next set of lanes. The following extract from Mrs Roberts' interview shows her frustration of not being able to avoid this time/place.

> *"I am really sad about this because I can't do anything about it! my children and I are exposed to so much air pollution every day and I can't do anything about it! I have to wait in the middle of the road for the light to change. I am trying to teach my children*

to cross the road in green but maybe I shouldn't! Maybe I should cross as soon as I have the chance so I don't have to stand there breathing the dirty air!

Mrs Roberts, M&BG

A week after the interview, I met with Mrs Roberts again. This time Mrs Robert's concern and frustration had taken another level. She felt that she had to do something to reduce her children's air pollution exposure and so she opted for drastic and dangerous measures.

"*I am now crossing the red man with the children!* (referring to the traffic light) *And I am planning to get a mask for my children! I have been trying to hold my breath when crossing the road, but my kids can't!".*

Mrs Roberts, M&BG

In this case, Mrs Roberts perceived air pollution as the most imminent risk, and she chose to cross the road while the traffic lights were in red in order to reduce her children's air pollution exposure while at the road crossings. She believed that she could cross the road quickly enough, so she would not get run over by a car. She felt that she had control over this. However, she did not feel the same way about her children's exposure to harmful pollutants: she felt powerless standing at the crossing lights. Therefore, even though the consequences of getting run over by a car were greater than the consequences of being exposed to air pollution for those two minutes, Mrs Roberts chose to evade the hazard for which she thought she did not have control over. Mrs Roberts also mentioned in the interview extract above, that she was planning to get a face mask to try to reduce exposure to pollutants. She told me that, while she was not entirely sure this would work, she felt that at least she would be doing something to try to reduce the amount of air pollution her children were breathing, particularly when crossing the road. This attempt to regain some sort of control to protect themselves from air pollution was also mentioned by other community group members. Unfortunately, adopting this action would have little or no impact at reducing the inhalation of harmful pollutants. It has been reported that commercially available face masks may not provide adequate protection, partially due to poor fitting (Cherrie et al., 2018), therefore placing the onus on the individual to protect themselves and raising many moral and ethical dilemmas. The latest Royal College of Physicians highlighted in its latest report that it is the polluter that should change their actions not those that are already suffering the ill effects of air pollution (Royal College of Physicians, 2018).

Physiotherapist Paul also gave some consideration to his likely exposure to air pollution while at the traffic lights. However, to reduce his exposure to harmful pollutants, he took a subtler approach.

> *When you're in that pollution, I tried to breathe more shallow, because literally I didn't want to take a big lungful of air. So, I tried to, you know, and especially going – you're coming up to a set of traffic lights and there's loads of cars just sat there and lorries pumping out – I try to kind of, if I see it coming, I try to hold my breath, as much of it as possible. I know it sounds silly, well, you know, three breaths of the bad gas is better than ten.*
>
> *Paul, COPDG*

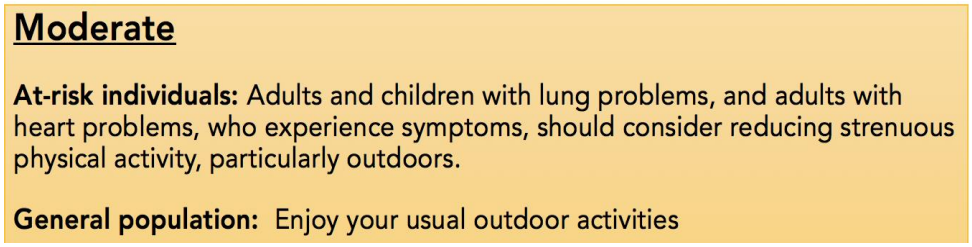
During this study, participants in general were inclined to judge the threat that harmful pollutants could pose to their health by comparing their own personal exposure data with that of others. This could have been driven by the fact that participants could not judge how "high" or "low" their results were compared to regulatory benchmarks. The empirical data presented in this section also suggested that people may be inclined to rationalise how they confront risk and act upon it based on how the risk is presented.

7.6 Who is most at risk from air pollution?

Whilst it has been argued that air pollution is a problem that can affect everyone (Holgate et al., 2016) akin to the risk society notions about 'universal risk', air pollution can harm some more than others, because their age or existing medical conditions make them more vulnerable (Simoni et al., 2015, World Health Organization, 2005a, Holgate et al., 2016), they live in deprived areas which often have higher levels of air pollution (Defra, 2006, Fecht et al., 2015), or because they work, live or study near busy roads (World Health Organization (WHO), 2013).

Air pollution is particularly harmful to people that live with a lung condition, such as chronic obstructive pulmonary disease (COPD), air pollution can exacerbate COPD symptoms and increase respiratory infections which can result in dangerous COPD attacks (Holgate et al., 2016). During this study, I saw first-hand some of the challenges faced by individuals living with COPD. While I was doing my field work at the COPDG I usually arrived early to the rehabilitation sessions, so I could greet the members of the group upon arrival. Most COPDG members travelled by public transport (bus and tube) and then walked to the venue. Those patients who had an oxygen tank normally travelled by car. One morning, as I was arriving at the venue, I saw Helen walking down the road, carrying the air pollution monitor accompanied

by her husband. Even though she was walking very slowly, she felt breathless and had to stop to catch her breath. As I watched Helen struggle, I checked the air pollution forecast for that day in London, it was "moderate" (Figure 7-3).



Source: http://www.airtext.info/he

Figure 7-3 Air pollution forecast example

It is not possible to say whether Helen's condition was aggravated by the "moderate" levels of air pollution, but what is certain is that Helen's physical activity was already being kept to the minimum and still she was struggling to breathe.

One of the strategies currently being used to inform citizens about air pollution episodes are the air pollution warning systems. Air pollution forecast systems (warning systems) have been put in place in many urban areas in developed countries, and there is evidence of awareness of air quality warnings, and a positive relationship between awareness and changes in outdoor activities (Wen et al., 2009). Together with an increasingly sophisticated monitoring, forecasting and reporting of air quality and the increasing trend among the public for more information (Kelly et al., 2012), the success of these communication tools ultimately depend on their ability to engage with the desired audience. It has been suggested that air pollution forecasting and reporting tools have the potential to empower people by allowing them to take action in the event of increased pollution (Kelly et al., 2012). However, one of the major drawbacks of communicating air pollution episodes through SMS messages (e.g. airTEXT) and phone applications (e.g. London Air Android app) is that it targets people with mobile phones. During my fieldwork, I noted that these tools were not entirely appropriate for raising air pollution and, or, communicating air pollution forecast information to certain groups of individuals. For instance, in general, primary school children did not own a mobile phone. Likewise, senior citizens and some of the elderly participants from the COPDG did not have a mobile phone, or, they owned a non-smart mobile phone, therefore, they could not download applications or access the internet. The main purpose of air pollution warning systems is to inform vulnerable groups about high air pollution levels, so they may take appropriate measures to reduce exposure. However, during this study, it was apparent that the extent to which those vulnerable people were being successfully engaged and informed was debatable.

The most severe case of COPD I saw was from a young man (mid-twenties) called 'Brandon', for whom the project findings were very disconcerting. Brandon enjoyed going out often to various places to visit family and friends, always travelling by car. He did not want to use public transport (bus, tube) as he was afraid that if he started having trouble breathing, he would not be able to get out. The first time I met Brandon, he came a bit late to our pre-arranged meeting. I later realised that he had arrived at the venue on time, but he could not get out of his car as he was struggling with his breathing. One of the other patients saw him in the parking lot and told the physiotherapist, who then had to run to the parking lot with an oxygen tank. When the physiotherapist finally managed to helped Brandon to get inside the venue, I realised the severity of his condition. Brandon kept apologising for being late, but he could not talk as he was struggling to breathe. It took about ten minutes for Brandon to feel better although I could still hear rattling sounds coming from his chest. Brandon carried the air pollution monitor for a whole week. Most of the time he reported in the activity diary that he was driving, and this was corroborated with the GPS signal. Brandon's results showed that the highest levels of BC recorded were when he was driving, at the car valet, while at dinner in a restaurant and at a car garage. Brandon timidly admitted that most of the time when doing the air pollution monitoring, he was in the company of his friends, who were often smoking cigarettes. Brandon's respiratory condition was being affected by his exposure to passive smoking. Physiotherapists from the COPDG argued that Brandon was not an isolated case, and that it was likely that for some of their patients, the concept of 'risk' was rather a personal judgment in which contextual factors (e.g. work environment, financial situation and relationships with family and friends) play an important role. Paul's interview extract below illustrates some of the physiotherapists' views in this regard.

> *"The people that I was dealing with, the patients I have contact with, were financially in a position where they couldn't change their environment. And therefore, although the data, they were aware of it, and they may be turning a blind eye to it before, it just meant that they have to resolve themselves to live with what they've got, because they don't feel empowered to change it, because people need to go round vehicles, and vehicles causes pollution. And until something happens at a state level, they will be just resolved and resigned to it. So I didn't see any of them wanting to join pressure groups any time soon. Yes, that's it really. So they, those patients are kind of in a little bit of a – they can sometimes feel themselves to be at a little bit of a dead end"*
>
> *Paul, COPDG*

While it seems that, in general, participation in the projects increased people's awareness of air pollution and, in some cases, inspired participants to change practice to reduce exposure to

pollutants, it is likely that for some people, the adopted changes may only have a short-lasting impact. The extent of this impact may have been in part driven by the participants' ability to gain control over their risk, for example, by being able or not being able to choose less congested streets to walk in order to reduce air pollution exposure.

Similarly, some study participants highlighted that the biggest victims of air pollution were not necessarily those whose health could be more at risk of being affected (e.g. asthmatics). Instead, they believed that the real victims were those who could not afford to get away from air pollution. They highlighted that many families in their neighbourhoods were only surviving today's tough economy, and that for them to think or to do something about air pollution was not possible.

> *"I'm in a fortunate position obviously now, but I think maybe some young people who are quite hard up are just finding – trying to find somewhere to live, maybe on a busy road, they're not going to turn it down because they need a home, they need accommodation for their family. They're not going to say, "Oh I can't live here because of the pollution." They must know the pollution is bad. But they are just trying to find somewhere to live".*
>
> *Lucy, SCG*

Many participants, especially those with young families, said that they would like to move out of London, away from the air pollution. However, they highlighted that although the current air pollution affairs in the capital had pushed them to revisit their long-term housing plans, it was not always possible to move immediately.

7.7 Air pollution a public health risk: From communication to action

Most participants across all groups agreed that air pollution was an issue of concern and even expressed their commitment to adopting new practices (e.g. taking a side street instead of walking through busy areas). However, during fieldwork, it became evident that the contexts in which people live their lives can influence the extent to which people think that "they can" or "they cannot" do something about air pollution. It was noted that there were feelings of powerlessness, compliance and detachment among participants.

Feeling of powerlessness: I perceived a sense of powerlessness from some of the most poorly patients from the COPDG who argued that there was not much they could do to avoid being exposed to air pollution when living in a built-up neighbourhood. They argued that the once quieter back streets have now become 'rat runs' as drivers try to avoid the traffic from the

main roads, consequently, there were not many quieter streets left to walk through in their neighbourhood. In any case, having COPD restricted their physical mobility, limiting their outdoor activities to only brief walks. Thus, opting to walk through quieter back streets which most of the time involved longer journeys, or visiting parks far from their homes, was not possible. During the education sessions where the results of the project were presented, some patients expressed their anger regarding the marked inequalities of their neighbourhood. They said that the people living in the 'island' (referring to Canary Wharf) were 'better off' as the levels of BC recorded around there were lower compared to those recorded elsewhere. Patients also said that there was not much point to imposing fines for polluting vehicles as wealthy car owners would probably pay the fines and carry on polluting.

Paul's (COPDG physiotherapist) views were very similar. He stated that although the project and the findings presented may have made patients more aware about air pollution issues, there was very little that some of his patients could do to reduce their exposure to harmful pollutants. Paul highlighted that for some of his patients adopting new practices would be very difficult as the areas where they live were characterised by deep social deprivation and poor environmental conditions. He argued that some of his patients were extremely vulnerable due to their health condition which affects their physical mobility, and that as a result, many of them were unlikely to be able to take an active role in reducing their exposure to air pollution. Similarly, while most participants from the P&BG expressed their intentions to adopt measures to reduce exposure to air pollution, some admitted having not been entirely successful with the implementation of their plans, particularly those for which the only walking route to school was through busy roads. They expressed the view that there was not much they could do to avoid exposure to air pollution. For example, Mrs Roberts said:

> *"Shocking! My daughter has a skin condition; she is more vulnerable! I don't really know what I can possibly do! Every possible route I can take is polluted! I don't mind walking more, but it seems that I don't really have alternatives!"*
>
> *Mrs Roberts, P&BG*

Fatalistic views, a belief that it was difficult to worry about things about which they could not do anything, were also expressed. Some participants claimed that, sometimes it is better to ignore things that they cannot control, and instead focus on things which they could influence and/or have an impact. The following extract illustrates.

> *"I think, yes I think we do, I think possibly that there's a sense that it's not something I can do anything about personally, so therefore I'm going to switch off and not worry*

about it, and worry about the things I can influence. I think, because that sort of factor, I think, can only be influenced communally rather than individually. It's not a matter of individual choice. It's much more difficult to get communal action behind policy change than it is – or what one chooses to do individually. So maybe there is an element of denial there out of a sense of helplessness or, 'I can't do anything about it. So, I'm not going to worry about it"

Tomas, SCG

Some senior citizens reported that they felt that they did not have any control over their air pollution exposure, at least not to the same extent as they had control over managing their weight or choosing to smoke. They highlighted that they had to use the infrastructure that was in place such as transport and roads and that there was little choice they could make around that. Similarly, some parents highlighted that they not feel comfortable letting their children cycle to school as they did not think the roads were safe for cycling, while others argued that it could be dangerous for children to walk through quieter back streets. Parents and children from the Primary school project also commented that their options for choosing quieter back streets to walk away from traffic were limited as busy roads were the only route they could take.

Feeling of compliance: Participants also highlighted that once people have lived in a busy environment for so long, things like dirt, traffic, and noise do not bother you any longer. Participants from the P&BG, in particular, felt that, as parents of young children, they were constantly receiving all sorts of advice and information about things they should or should not do to protect their children from harm (e.g. buying organic food, not using chemical products at home etc.) Some of the mothers commented in interviews that sometimes they feel that having young children and full time jobs was more than they could handle. As a result, most of the time, they had to disregard the information and advice they received, the more facts the less concern.

"I think that if you're not willing to make changes then maybe you don't want to hear about it. I mean that's my attitude as well, ok too much! I can't have another change in my life or something, like don't tell me about it because then you're making me feel guilty about not doing something about it."

Adison, P&BG.

Feeling of detachment: Participants, particularly the senior citizens, argued that information about a premature death caused by exposure to air pollution was of little or no relevance. The quotes below clearly illustrate this.

> *"I just get on with it, I think. I'm seventy-one, and, you know, I've survived this long. And how much longer I'm going to survive, I don't know. But just accept it really, it's the polluted world we live in. It's the way we live isn't it?"*
>
> *Penny, SCG*

> *"I personally, I mean I wouldn't want to be obese for other reasons. I know I'm going to die. And actually, I don't really care at what age I die at, it seems strange. I find all the stuff about, you know, these things causing premature death slightly irrelevant, I suppose, in a way. I don't want to suffer for long before I die, then I don't care when I die. So, I'm not particularly bothered about it. As I say, if it causes you a long period of bad life, if you like, that's a bad thing. The fact that it reduces, brings forward the day I'm doing to die by six months is frankly of no interest. It's always going to be a bad day isn't it?"*
>
> *Kiran, SCG*

A few participants across all groups expressed the view that although they found participation in the participatory air pollution monitoring projects interesting and informative, they were not concerned about being exposed to air pollution as they could not 'feel' how this could affect their lives. As far as they were concerned, they were healthy individuals who did not have to worry about these issues. As discussed in Chapter 2, air pollution can cause short term and long-term health effects. Short term effects are caused during short but intense air pollution episodes (e.g. heavy traffic in rush hour). Long term health effects, on the other hand, can happen at lower air pollution levels than those that cause the short-term health effects but can last for many years or for an entire lifetime. While many people will not notice any ill effects during short-term air pollution episodes, those who are sensitive (e.g. people with breathing problems) can be severely affected, making the air pollution problem very tangible to them. Therefore, it could be that the biggest challenge about communicating air pollution as a health risk may be to convey information about the long-term health effects, as these are not necessarily visible and imminent as the short-term health effects.

7.8 Reporting back findings - social implications of risk perception

During this study, participants who carried out the air pollution monitoring received an individual report of the data they collected. The air quality data was presented to participants

using graphs, tables and maps, and these reports were given to participants face to face. The results from this study seem to indicate that in general, having access to personalised air pollution exposure data increased participants' air pollution awareness and inspired some of them to adopt changes in practices to reduce exposure to pollutants. However, it is important to consider that this approach could also have the potential to influence and reshape individuals' perceptions of risk and hence the way they acted upon it. The widespread use of biomonitoring techniques, that allow individuals to access their own personal exposure data, has attracted the attention of social scientists who are increasingly concerned about the social implications that this could have on the wellbeing of individuals and their communities (Washburn, 2013). Some scholars advocate for the use of report back strategies, arguing that individuals have the right to know what they are exposed to, and that access to this information will allow them to make informed decisions about how to avoid or minimise their exposure and hence, reduce the associated health effects (Brody et al., 2007). Furthermore, access to results from biomonitoring interventions has the potential to empower individuals and communities inspiring them to take action to advocate for better environmental conditions (Washburn, 2013, Altman et al., 2008, Adams et al., 2011). On the other hand, other researchers argue that reporting back the findings of personal exposure monitoring could generate anxiety and frustration (Washburn, 2014, Quigley, 2012). This is especially the case where there are no clear ways in which individuals could avoid or minimise their exposure to contaminants (Harrison, 2008). Washburn highlights that there is not enough evidence in order to support either side of the argument as there are not many studies that have documented the personal experiences of people that received biomonitoring results (Washburn, 2014).

The possible implications of reporting back personalised air pollution data became evident very early in my field work when trying to engage with gatekeepers to get access to the community groups. As I was contacting primary schools to conduct my first project, a Research Associate in Engagement at KCL helped me get in touch with a science teacher from a south London primary school who thought that the air pollution monitoring project could be incorporated into his science lesson. I met with the teacher, 'Sahib', just once, as unfortunately, after I explained the project practicalities, he was no longer interested in taking part. Sahib explained that many of the children attending his school were from troubled homes and that their parents had to deal with imminent problems (e.g. 'putting food on the table' and 'making sure their children stay away from trouble'). He argued that if parents knew that their children were exposed to harmful pollutants and that this exposure could have damaging effects on their health, they would only feel more frustrated and anxious. Sahib declined my invitation to take part in the project stating "It is better if they don't know", "they have too much to worry about already". After this experience with the primary school, and in order to alleviate the

possible negative consequences that access to personalised exposure data could have on participants, I thought it was important not only to identify the air pollution problem and make individuals aware of it but also to provide participants with clear advice as to how their exposure to pollutants could be avoided or reduced. Adopting this approach throughout this study seemed to have had a positive impact among most participants who were able to understand the results without undue alarm, as they felt that, to some extent, there were things they could do to reduce their exposure to the risk of air pollution.

7.9 Discussion

In the field of air quality, health risks are generally calculated based on the probability that exposure to a certain pollutant will result in a given adverse physiological effect in the studied population (Koenig, 2000). This form of risk assessment is based on objective information only (e.g. concentrations of air pollutants, period of exposure etc.,) and not on subjective perceptions of risk (Gatersleben and Uzzell, 2000). In this chapter, I explored how risk to air pollution, which is characteristically a calculable risk, was understood and perceived by a range of individuals who took part in a participatory research intervention, where they had the opportunity to measure their own exposure to air pollution.

According to Beck's notion of 'risk society', modern risks are largely the result of human activity, characteristically universal, and difficult to perceive directly and hence experts are needed to make them visible (Beck 1982). It can be argued that the risks posed by air pollution are indeed 'side-effects' of modernisation (e.g. higher car use) and are characteristically universal (individuals are exposed to the same level of risk) as Beck's notion of risk society suggests. However, while air pollution is a risk that can affect us all, there are certain individuals, as identified in this study, who are more at risk of air pollution, such as those who have worse health conditions or those who live in particularly polluted areas. Similarly, while Beck argues that sophisticated technical equipment and experts are needed to make modern risks visible, the results obtained in this study indicate that modern risks such as 'air pollution' can also be made visible by lay people through participatory research interventions, such as the one carried out during this study. This, however, can be seen as a way of placing the responsibility of protecting the public's health on the members of the public themselves (Lupton 1996).

Furthermore, using a participatory research approach gave me the opportunity to establish a two-way communication process whereby participants were able to express their views regarding how they thought it would be best to present the findings and what sort of information should be included in the feedback reports (e.g. offering participants the

opportunity to see other people's results to help contextualised their own). The results from this study showed that, in general, having access to personalised air pollution exposure data increased participants' air pollution awareness and inspired some of them to adopt changes in practices to reduce exposure to pollutants. This suggests that personal air pollution measurements could have been seen by participants as a more reliable and accurate source of information on which to act upon than purely human intuition (Lomborg, 2017). However, having access to this source of information could generate anxiety and frustration (Washburn, 2014) and it could lead to people adopting risky measures to reduce their exposure to air pollution, putting themselves in harmful situations. This study found that careful consideration should be placed on balancing benefits and harms from receiving information about air pollution exposure. It is therefore, of particular importance that information about the potential risk of exposure is coupled with key messages on actions that people can themselves take to reduce their exposure to harmful pollutants.

The results presented in this chapter also highlight that there are a number of factors which can influence how people perceive the risk and how they rationalise their decision-making process when ranking the severity of the risk. Risk perception can be influenced by the inherent nature of the risks themselves (Gatersleben and Uzzell, 2000). This includes factors such as whether the risk is voluntary or not (Otway and Von Winterfeldt, 1982) (e.g. active smoking vs passive smoking), the extent to which people feel they can control the risk (e.g. using masks to limit air pollution inhalation) and the time span over which harmful effects can be observed (e.g. short and long term effects to air pollution) (Gatersleben and Uzzell, 2000). These, I argue can also be seen as barriers for communicating air pollution as a health risk. For example, it would be difficult to engage with people and to initiate conversations about air pollution, if people feel that they don't have any control over their exposure to harmful pollutants (a sense of powerlessness).

In the following chapter, I will focus on exploring participants' views regarding what they consider to be the cause of the problem, who they think is responsible and what they think should be done to address the issue.

Chapter 8 - Results: Participants' perceptions of air quality policy

Introduction

This study posed the following question: "Can community-based participatory research interventions, which involve the collection of personalised data, be used to aid the development of effective methods of engagement with community groups to improve the local environment and public health?" In Chapter 6, I described how a participatory research approach was applied to this study and I reported on the experiences of those who took part. In Chapter 7, I focused on exploring people's understandings of the risks posed by air pollution, considering my results in the light of Ulrich Beck's notions of 'risk society' (1992).

In this Chapter, I address the thesis sub-question "How do people, who take part in participatory air pollution research using personal air pollution monitors, perceive air quality policy and can this impact on policies to tackle air pollution?" I will discuss how the people who took part perceived air pollution, particularly, in regard to what they considered to be the cause of the problem, who they thought is responsible for dealing with air pollution and the extent to which they felt that they can contribute to tackling the issue. In this Chapter, I will also report their views for future policy interventions. I argue that understanding public attitudes and the acceptability of policy choices is important for planning and delivering more effective air quality interventions in the future.

While study participants were not asked directly what they thought about policy or policy interventions, these were topics that were repetitively mentioned in the participants narratives (interviews and informal conversations). The participants' accounts presented in this thesis correspond to field work carried out between 2015-2016. Therefore, their narratives should be considered in the light of the events taking place during that period as presented in Chapter 4.

8.1 Public policy, science and the public

'Public' policies made by governments affect us all inescapably, at many different levels and in a range of contexts. For example, policy controls how our waste is collected, transported and disposed. Policy regulates transport infrastructure, fares and the safety of passengers. In the field of air quality, policy determines the quality of the air we breathe by setting limit values for key pollutants, which are considered to have an impact on health and on the environment such as particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO_2).

Policy also decides which, if any, interventions to implement to address the issue of poor air quality. But what exactly do we mean by public policy? A well-known simple and short definition for public policy has been proposed by Thomas Dye:

'*whatever a government chooses to do or not to do'* (Dye, 2017, p. 1)

This definition implies that the main agent of policy making is the government and its decision to choose to do or not to do something (implement a policy) can have an impact on society. Although, other actors such as pressure groups, NGOs, academics and the public may have also a role to play in the policy decision-making, the extent to which these actors get involved is controlled by the government, who ultimately makes all the decisions on behalf of the citizens (Howlett and Cashore, 2014). For example, scientists can measure air pollution, find associations between poor air and health impacts, and propose air pollution reduction strategies, however, the proposed solutions to tackle air quality do not necessarily become 'public policy', they remain as information and or advice. The government decides whether to implement or support scientific advice, therefore giving origin to public policy (e.g. Regulation, that sets limits on a number of pollutants that can be released into the atmosphere). Though, it has been argued that in a democracy, public policy is a function of public opinion (Wlezien et al., 2009), where policy agendas are set as a response to public demands. Therefore, it has been suggested that engaging the public in a dialogue with science (which will then inform policy), could reduce the public's opposition to policy implementation (Bauer, 2009). This approach can be regarded as an alternative approach to the "information deficit model' which assumes only a one-way communication model. Through a dialogue approach, the public is an active part of a two-way discussion where benefits, but also drawbacks are considered (Wooden, 2006). Calls for more inclusive and transparent processes which involve the public has become increasingly common in Europe. For example, the Horizon 2020 program (the biggest EU research and innovation program), includes a Work Program 2018-2020 (WP18-20) called "Science with and for society" (SWAFS) which aims to support the evolution of the relationship between science and society (European Commission, 2018). Steps towards involving the public into policy-making have also been made by the UK Government. In its plan for Civil Service Reform, published in 2012, the government introduced the notion of "open policy-making" with the objective of engaging the public and experts in discussions about the policy-making process. This was done as an attempt to move away from conventional policy making where the public is informed after decisions have been made, to a new model where citizens are consulted throughout the policy making process, in order to identify problems and best courses of actions (House of Commons,

2013). While these are steps towards a more active relationship between the government and citizens, questions about the extent and success of the engagement still remain. It could also be argued that efforts to engage with citizens in science and or policy-making are made as attempts to get back trust and support from the public, who has grown sceptical of governmental risk-handling (Irwin, 2006).

For the purpose if this research, policy has been understood as a set of initiatives and guidance to reduce air pollution in order to protect human health and the environment.

As discussed in Chapter 6, the findings from this study suggest that by taking an active role in the research process, individuals are inspired to not only reduce their own air pollution exposure but also to think about ways in which they could reduce their own contribution to the problem. But what is the impact that taking an active role in research can have on the way participants think and feel about air pollution and associated policies? In order to shed some light on this question, I will first start by presenting what participants considered to be the cause of the air pollution problem and who they thought was responsible for dealing with the issue.

8.2 What did participants perceive as the main cause of air pollution?

Throughout my fieldwork, discussions with participants across all groups about air pollution and policy always touched upon the "diesel" issue. While high volumes of traffic, lack of efficient modes of transport (so people are forced to use cars), construction sites and aircraft emissions were also mentioned as causes of air pollution, most participants believed that diesel cars were the ones to blame. The participants' marked views towards diesel cars might have been influenced by the media's portrayal of the issue as reported in Chapter 5.

Back in 2001, diesel was advertised as the wonder fuel. As highlighted in Chapter 2, in order to cut down on CO_2 emissions, tax breaks were introduced to encourage people to purchase diesel cars. People at this point were engaged with these policies and this was reflected in the amount of new diesel cars bought over the coming years. In the UK, for instance, diesel vehicles accounted for fewer than 1 per cent of cars on the road in 1984, while in 2014 that figure had risen to more than a third, with new registrations totalling about half of all new cars in 2014 (SMMT,2014). While diesel engines generally emit less CO_2, one of the main gases associated with climate change (Rashid, 2013), they can emit other pollutants, notably nitrogen oxides NO_x, which are big contributors to the current air pollution in cities and are harmful to human health (Beevers et al., 2012, Holgate et al., 2016). It was not long after the government had changed its mind regarding diesel cars and had started to discuss policy interventions such as taxes and scrappage schemes aiming at discouraging their use, that the 'Volkswagen scandal' hit the headlines. It was reported that many cars were cheating emissions test to make

them appear less polluting than they really were under normal driving conditions, therefore, emitting more NO_x that previously thought (Brand, 2016).

It has been suggested that the level of public concern about environmental issues tends to be proportional to the amount of media attention received (Mazur and Lee, 1993). Furthermore, it is important to consider the role of the media in influencing how risk is presented within society (Wallington et al., 2010) as newspapers, radio, the internet etc., are all resources that the public may draw upon to form their understanding of the risks posed by air pollution. A conceptual framework to understand the public response to risk known as the "social amplification of risk" asserts that risk and risk hazards interact with physiological, social, institutional and cultural processes in ways that may amplify or attenuate public's perceptions and responses to the risk or risk event (Kasperson et al., 1988). Signals about risk are processed by individual and social amplifications stations, including the scientist who communicates the risk assessment, cultural groups and the media (Kasperson et al., 1988). The risk event itself can be meaningless, however, the social amplification stations charge it with meaning and messages. (Lidskog and Sundqvist, 2012). However, it has been argued that these intermediaries could distort the information given to meet their own agenda, therefore, leaving the public with mixed messages, making the conceptualisation of the risk challenging (Lupton, 1993).

The importance of the role that the media has been playing in informing the public about air pollution in London was evident in the participants' narratives across all groups. As highlighted in Chapter 5 section 5.4, it is clear that air pollution/air quality related issues were being highly portrayed by the media during the time of my fieldwork. In general, participants reported having heard about air pollution through newspapers and TV reports. The quote below illustrates.

> *"There's an awful lot about pollution in the press as well, and in the internet, be it cars or generally speaking or in the world news. For a long period, there was a lot about Chinese cities, or you know filled with 'pea souper smogs' like we used to have here, luckily before we were alive. At least things have moved on a little bit. I think people are interested anyway".*
>
> *Tim, Father, P&BG*

Furthermore, it was also reported by some participants, particularly those from the senior citizen group, that the data gathered throughout the air pollution monitoring confirmed what they already knew from media reports (e.g. that London suffers from traffic related pollution).

I think it made me more aware and it confirmed what I already knew, because I've heard about it in the media. And now they're talking about taxing diesel cars aren't they?

Penny, SCG

The findings from this study show that participatory research approaches, using personal monitors, can help the public identify and recognise that there are multiple sources of air pollution. For instance, those participants who mentioned constructions sites as sources of air pollution had visited and or passed by a construction site while doing the monitoring and therefore, they had seen first-hand that a construction site can also contribute to their overall exposure to air pollution. Similarly, by measuring their own personal exposure to harmful pollutants, participants were able to identify other sources of air pollution which they were not aware of (e.g. emissions from gas cookers/gas appliances). The following extract illustrates.

"Oh I thought that was a lot more effective than leaflets or information because then you get to see, kind of like you said, you could just see how, you got to see all the different variables, like you got to see the construction site, you got to see this and that, it's not just… oh bus shelters are bad places to stand!".

Rose, M&BG

This suggests that participatory approaches to research which involve the gathering of own personal exposure data have the potential to help citizens to identify the multiple sources of pollution that they may be exposed to as they go about their daily lives.

8.3 Responsibilities and trust

The UK government's U-turn on diesel, together with the Volkswagen scandal had affected participant's trust in government interventions as their narratives suggested. While the diesel scandal was directly linked to carmakers, most participants who touched on the diesel issue, did not mention carmakers' involvement or accountability. Most centred their narratives around the government's responsibility and or how their trust in the government, and its policy interventions, had been affected. While people in general were inclined to assign responsibility for air pollution to governmental institutions, at the same time they were doubtful of the government's ability to deal effectively with the issue.

Participants, particularly from the Breathe London Projects (BLP), argued that they did not understand why it was taking so long for the government to take action to tackle the air pollution problem in London, when the source of the problems was so clear. The following illustrates.

"Most of us, we just commute in to the city and we live somewhere else. A lot of people live in cities like this and has no choice. And they're stuck with it really. And we need to – it's vital, we have to change, we have to change. We know how we can change it, it's not as if we're not – we're not a developing country where they have lots of other issues which adds to the air pollution. Ours is just, as I understand it, around diesel fuels and if that can easily be done, then why aren't we doing it?"

Kate, The Air We Share campaign – BLP

Discourses about 'diesel vehicles' were varied and were mostly a reflection of participants own situations. For instance, those who did not own cars, were strong supporters of measures that aimed at either taxing and or banning polluting cars from entering certain areas in London. However, the views from those participants who owned a vehicle, particularly for those who had diesel cars, were somewhat different:

"My diesel car, it's an HDI diesel, very, very high performance, well, adequate performance and it's the best performing car I've ever had. And it's low, I get a lot of mileage out of it especially if I drive it slowly. If I drive down to Brighton, as I do, to see my daughter, at 55 miles an hour, I mean the fuel gauge hardly moves. If I do it at 70, I will actually use more diesel. So, I think this is a fantastic machine. So, I shall be very, very reluctant. But I'm hoping that petrol engines will be developed, which give better performance. That's the only thing one can hope. When I bought this car, I thought when I got this car, I thought it would be my last car. I wouldn't buy another car after this. Diesels have long, diesels have longevity. And mine has done just over 50,000 miles and it will be good for 200,000 miles. So, I don't really want to get rid of it.

Mr Woods, SCG

It has been reported that public acceptability of policy interventions tend to be greatest for interventions targeting the behaviour of others, rather than the respondent's own behaviour (Diepeveen, S., et al, 2013). Participants who were owners of diesel cars expressed their views with anger and frustration. They argued that the government had put them on a difficult situation, where they either got rid of their diesel vehicles or bore the burden of paying extra taxes to drive them. Diesel vehicle owning respondents argued that they normally used their cars for travelling long distances and that their cars were far more efficient over long distances compared to conventional petrol cars. They also argued that their vehicles had still a lot of "life" in them and that a scrappage scheme would be a "waste of the earth's resources". Participants also highlighted that they felt "betrayed" by the Government. They argued that in

"good faith" and trying to help the environment as per Government's information, they purchased a diesel vehicle over a petrol vehicle, and now they are being hit the hardest by punitive levels of taxation. The following interview extract illustrates.

> *"You know, they told us all to buy diesel cars twenty years ago. They said it was going to be cheaper, it's going to be great. And now they're going, "oh no, that was wrong." I mean they get it wrong so often, it's a joke. So, you know, the pollution levels, I'll be dead before they do anything about the pollution in this town, that's for sure. They'll be twenty, thirty years of people having to drop dead. It was like, when I was a child, the smog – I was in London during the smog. It wasn't until the '62 that the Clean Air Act came in. I was a young man, you know. People dying, dropping dead on the street going home. That's when they did something about it. And that's the only time they'll do anything about pollution in major cities. But all they do is keep pull, pulling more people in, giving them more cars. I mean, in the last twenty years, just twenty years ago, I could – I'd just come home any time of the day or night and park more or less outside my house. Now, if I come home past nine o'clock, I've got to go two streets away to park the car. You know, there's twice as many cars in the last twenty years on the road. I don't care what their figures are, I know. And, you know, but they're not going to do anything about it. No one is going to do anything about it, not in my lifetime. Hopefully in your lifetime. But it won't be until people start dropping dead in the street and the politicians - "Oh we've got to do something about this." But I've got a diesel. I've got a diesel camper van I bought, you know, I've had it what, twelve years now. So, twelve years ago it wasn't so key. We didn't have so much information as we do now".*
>
> *Sam, COPDG*

While non-car owners advocated for taxes and diesel-banning schemes and diesel car owners argued the unfairness of their situation, participants like Tim, who had a diesel car and a vulnerable family member at risk of health complications due to air pollution felt at a dead end. Tim, father of a 20-month-old baby with cystic fibrosis, and diesel car owner, felt very anxious about having a diesel car whose emissions could be directly affecting his baby's health. Exposure to air pollution has been associated with exacerbations in patients with Cystic fibrosis (Goeminne et al., 2013). Tim argued that he trusted the government that buying 'diesel' was the right option, and that diesel vehicles had been represented as being fuel efficient and environmentally friendly. Tim reported feeling not only betrayed by his government but also helpless. He felt that there was nothing he could possibly do. He could not sell his car as it had now lost value, and he could not stop using his car as he needed it to

go about his daily routines. The benefits of car use can be perceived at an individual level, while the disadvantages have a more collective connotation (Gatersleben and Uzzell, 2000).

8.3.1 Air pollution does not receive the attention it deserves

While most participants across all groups acknowledged that air pollution is a complex problem (for example, because of its invisibility), they also argued that this should not be an excuse for the government not to do anything or to delay action. Some participants considered air pollution to be a public health risk which has not received the attention it deserves:

> *"Because you see air pollution is a public health risk like obesity and smoking and we have lots of propaganda for obesity and campaigns and things, but although air pollution is almost at the same level, we are not giving the same attention"*
>
> *Elliot, (Max's father) Primary school*

Similarly, environmental campaigners from the 'Breathe London projects' (BLP's) believed that air pollution should be treated as an immediate threat to citizens, and as such, should be dealt with promptly. Participants argued that the government should take strict measures to tackle the issue, as it has done with other public health problems such as tobacco smoking. The following interview extract illustrates these views.

> *"I mean, for example, there's lots and lots of things about smoking. But at the end of the day, smoking is a voluntary behaviour. Okay, and so a subset of the population. And you can decide, even though it can be difficult if you're addicted to cigarettes, I mean you can decide, "I'm not going to smoke, I'm going to quit smoking." And actually, the government has pushed that because, you know, cigarettes are much more expensive, cigarettes are heavily taxed, you can't go and smoke in a pub any more, you have to go out like some sort of outcast, you know, like a leper, you know. So, I mean less people are smoking than there used to be, you know. And actually, the rest of us feel better about it, because now we can go out and hang out in a pub without smelling like an ashtray afterwards. I remember the old days, you know. So, air quality needs to be treated like that, because air quality – it's not a voluntary exposure. It's not like we're eating something that's bad for us. You can make a decision to eat something that's bad or not, you know. You can say, "Bacon is bad for you, so I'm only going to have bacon once a week instead of every day." That's a decision. You can't make a decision about the air you breathe. I mean it's involuntary. You're breathing, how many breaths do you take in a day, you know. Four or five a minute? how many minutes? – you take*

thousands of breaths a day. And you have to breathe the air where you are. I can't say, "Well I'm here, I'm going to take my breaths from over there where it's clean." It's involuntary, it sorts of affects everybody. It's like water quality too. You know, even water quality you have options, you know, if the water that's coming out of your tap is polluted, you can go and buy bottled water, or you could buy a filter. Short of walking around with, you know, a respirator and a gas mask, there's not so much you can do about, you know, the baseline quality of the air we have. So, because it affects everybody, I think the government needs to take stricter measures".

Ben, Open Streets London, BLP

Participants, particularly those from the BLPs felt that air pollution was a topic very much neglected by council officials. They described attending meetings with public health officers, where, despite the aims of the meeting being to identify measures to protect public health, air pollution was not even on the agenda, and the focus was placed on smoking cessation and obesity.

8.4 Participants' views on policy interventions to tackle air pollution

Across all groups there was a sense of disproval from participants towards policy interventions to tackle air pollution which involved financial punishments. For instance, some participants expressed the view that policy that involved introducing taxes to tackle air pollution, referring to the congestion charge[5] had a huge financial impact on less affluent citizens who are forced to enter the city due to work or unavoidable commitments (e.g. hospital appointments, small business). During one of the results feedback sessions at the COPDG, I observed a group discussion in this regard. There were about 8 patients (participants) present. As previously planned with the physiotherapists, the results were presented as a part of their air pollution education session. On that day, the information session was led by the physiotherapist and took the form of a true/false game using pictures of different sources of pollution. This short activity was then followed by the project results presentation. While discussing the findings (e.g. sources of pollution, hot spots etc.,) participants angrily noted that "people living on the island" (Isle of Dogs) were "much better off" as the levels of black carbon (BC) recorded around there (as per project results) were much lower than those recorded elsewhere in the borough. Participants also argued that there was not much point on "setting fines for polluted vehicles, as owners will probably pay the fines and carry on polluting". Participants were

[5] The London congestion charge is an £11.50 daily charge for driving a vehicle within the charging zone in central London between 07:00 and 18:00 Monday to Friday.
Source: https://tfl.gov.uk/modes/driving/congestion-charge

trying to make the point that charging drivers to enter the city centre would not necessarily deter affluent citizens from driving inside these areas as they would still be able to afford the charges.

Many participants across all groups argued that instead of "punishing" people for using polluting vehicles, a reward approach should be adopted, so those citizens, companies, and industries that are adopting environmentally friendly technologies/measures are praised for their efforts. This, in turn could encourage others to follow as they see the potential benefits (e.g. monetary benefits) of adopting cleaner ways of getting around the city. The following illustrates.

> *"I think, from the government's point of view, it would be costly to attack it, because a lot of the pollution is from heavy transport rather that people's cars. And there's been a lot in the paper recently about diesel fumes causing more particulate pollution than petrol fumes, and that they should tax diesel because of this, which would affect – isn't going to happen, because it would affect transport. And if you cause transport to cost more, it would put up prices for everybody. And that's what people would object to. I think the way that they would have to go about it, is to reward the use of clean air things, so that it is worthwhile people, for example, using less lorries and putting more stuff on to trains"*
>
> *Claudia, SCG*

In general, participants expressed the view that improvements in transport infrastructure should go hand in hand with efforts to tackle air pollution. They argued that people could not be asked to reduce their car journeys if there is not a proper, well-organized transport infrastructure in place. For instance, many parents and children from the primary school project highlighted that if they were to try to cycle to and from school with their children, the appropriate cycling infrastructure (designated cycling lanes) should be available. Participants also highlighted that planning decisions should be carefully considered in light of current air pollution problems. For example, limiting the amount of personal parking that comes with new residential developments and instead offering the right infrastructure for safe bicycle parking and storage.

Participants also highlighted that planned policy interventions should not only be limited to addressing air pollution problems but, at the same time, they should also provide other types of communal benefits. For instance, some participants highlighted that reducing traffic levels would not only improve air quality, but it would also have a positive visual and a noise impact in and around neighbourhoods. Other participants highlighted the benefits of promoting active travel (e.g. cycling, walking). They argued that encouraging people to cycle instead of using

the car, would not only reduce air pollution levels, but it would also help to get individuals active and this would generate further positive health impacts in their communities.

I found the views from Member of Parliament, Mr Williams, in regard to policy interventions to tackle air pollution very interesting and potentially important. Mr Williams told me that he felt that air quality policy should not only be targeting air pollution originated from transport sources while overlooking other sources of pollution, such as air pollution from UK shipping. Mr Williams views were a reflection of the air pollution situation of his own constituency, where air pollution from UK shipping was a big problem, often dismissed. He explained that, currently, most cargo ships and cruise liners docked in London and in small coastal towns ran their engines on diesel generators, polluting the air in the surrounding areas. He believed that it was crucial to invest in alternatives to power generation such as electricity supply at port sides. Having the opportunity to gather the views of a member of parliament, who took part in a participatory research exercise where he gathered his own air pollution exposure data, allowed me to see the potential of participatory approaches not only for engaging with lay individuals but also with politicians. In this case, through participation in the project, Mr Williams was able to think about how the sources of air pollution were actually rather more "subtle than one might initially think" and about the importance of addressing holistically those various sources of pollution (e.g. fumes from cars, emissions from shipping etc.,) which together make up the whole picture.

Participants also highlighted the extent to which they felt engaged with policy initiatives and how they viewed the implemented measures. For example, few study participants highlighted the positive impacts that certain policy interventions to tackle air pollution have had on their neighbourhoods. Senior citizens, in general, reported being highly supportive of pedestrianisation and they commented on their own personal experiences in their city centre. They highlighted that having an area free of traffic in the centre only reduced the amount of air pollution in this area, but also gave the community other added benefits, such as making spaces for recreational purposes (cafes and benches) and safety for pedestrians, especially the elderly and children.

It has been recognised in both, UK legislation and EU legislation that the policy making process should include a bottom up approach as opposed to the only conventional top down decision making process (House of Commons, 2013, GOV.UK, 2012). Furthermore, The European Commission, in their Better Regulation Package adopted in 2015, had also manifested their desire to offer citizens the opportunity to be part of the full legislative cycle. The commission emphasised that opening up policy-making to the public will give citizens

the opportunity to be informed about the features of the relevant issues at stake, and that this will help them better understand the impact that legislation may have (European Commission, 2015).

During this study, most participants across all groups expressed the view that in order to tackle the air pollution problem in London effectively, a combination of both a strong political commitment to addressing the issue, but also citizen acknowledgement of the issue which could in turn lead to action towards the issue was needed.

8.4.1 Citizens' responsibilities and the role of advocacy

While most participants highlighted what they believed to be the causes of air pollution (e.g. high volumes of traffic), the number of participants who reported to feel personally responsible for the air pollution problem was limited. Participants' discourses mostly focused on the things that they did, that did not cause air pollution, e.g. "I cycle to work", "I do not use the car". Participants, in general, highlighted how 'others' were the producers of air pollution e.g. the neighbours, delivery vehicles, motorists, the Sahara desert etc. The only study participants who felt partially responsible for the air pollution problem were those who owned a diesel car. The following interview extract illustrates.

> *"Well if my husband stopped having a diesel car, that might help. But then there was a time a few years ago when the government said it was good to have diesel cars. And we still have one. That sort of bugs me a bit. Well he likes the car, so he won't get rid of it yet"*
>
> *Maggie, SCG*

Participants agreed that while the emissions from their car could be adding to the air pollution problem in the city, this was not their fault, but that of the government, who encouraged them to buy a diesel car in the first place. Few participants reported that there were actions which citizens could adopt to improve air quality in and around their neighbourhoods, with most arguing that, ultimately, the government was responsible for the current air pollution problem and had a duty to tackling it.

> *"The governments must do something about this air pollution, I mean, or even, as individuals, you know, you use as little as possible. You walk. I made the children walk to school because if you take the car, you would have been just crawling along – there's so much traffic every morning".*
>
> *Renata, SCG*

The narratives from participants that took part in the Breathe London Projects (BLPs) (e.g. environmental campaigners, local community leaders, journalist) noted the role of the government at tackling the issue through policy implementation and information delivery to inform citizens about things they could themselves do to address the issue. The following extract illustrates:

> *"I mean you've got the sort of issue of diesel cars, you've got the ultra-low emission zone that's going to come in. I mean I've always thought with big change things, you – it's a two-pronged attack. You know, you can get the message out, you can make people change their individual habits, you can hopefully get more people doing cycling, walking, getting out of their cars. But I also think the government, or the mayor needs to incentivise people to make that easier option to do. So, for example, you know, with plastic bags, people said for years and years and years, "Oh we should use less plastic bags." And we're using slightly less. Now they are put a 5p charge on, the number of plastic bags have been cut massively. So, I kind – I just feel, with things, it's very easy to be lazy and just switch off and not really care about it, unless there is some form of financial punishment or incentive or something that comes from the top-down. I think that can make a huge difference, whilst still doing the stuff bottom-up in terms of giving people the information to make the small changes. But I think you need a combination of both".*
>
> *Robert, The Cycle to Work Study – BLP*

Some participants did identify actions they could take to improve air quality such as cutting down on the number of private car trips and shifting towards cleaner technologies such as electric vehicles. However, some like Laura, from one of the Breathe London Projects and a sustainable transport specialist, highlighted that technological fixes (e.g. electric cars) to lessen the air pollution problem in cities would not help with other problems such as congestion and road safety as we would still have large amounts of vehicles on the roads.

I noticed that remarks about the wider adoption of new technologies such as electric cars were presented only by participants from the SCG and BLP. This could be a reflection of participants social-contexts. For example, the senior citizens involved in this project, were from the University of the Third Age group (U3A), where they are continuously learning about a wide variety of topics. Similarly, participants from the BLP were observed to be committed and passionate towards environmental issues, hence environmentally friendly technologies may probably be something they were familiar with. Participants from these groups argued that a move towards electric vehicles should be approached with caution, and careful

consideration must be given to the energy source. Most were particularly concerned that increased power generation from fossil fuels, to cope with the electric cars demands, would lead to more environmental problems.

Many participants agreed that they, as citizens, had a role to play not only to reduce their air pollution exposure but to improve air quality. However, some argued that in order to do the "right thing", they first needed clear information and advice about what actions citizens could do to help. Furthermore, participants highlighted that in order to stimulate citizens' changes in behaviour, the government should provide them with a) appropriate infrastructure (e.g. cycling lanes, cycling parking facilities, adequate alternative modes of transport) and b) incentives to adopt good practices.

Some participants, across all groups, felt that they should, themselves, take a leading role in their communities. They argued that they could use the data gathered through their participatory air monitoring as evidence of the magnitude of the problem to lobby council officials to take prompt action to address local air quality issues. Studies have also documented the perceived success of community-based participatory interventions among communities which were subject to the effects of various polluted conditions (Corburn, 2005). In his book, Corburn presents four case studies from Greenpoint/Williamsburg, in New York City, where diverse community groups organized around complex environmental health issues (subsistence fishing risks, asthma, childhood lead poisoning, and small sources of air pollution in the local area), and practiced what Corburn called "street science". Corburn highlights that through these community-based studies, difficult to reach populations were able to take an active role in the research process, identifying relevant research questions that otherwise could have been ignored by professionals, and obtaining hard to gather data. Furthermore, the author, claimed that these studies have helped communities to lobby government institutions into remediating pollution incidents by presenting them with evidence collected by themselves.

In the course of fieldwork, I interviewed Margaret, an air quality advocate who was active in the BLPs. She told me about how she had used her own air pollution monitoring data to put pressure on local council officials when there was a risk that pedestrian paths across the housing estate where she lived might be closed. The data she had collected in her air quality project, the Dog Kennel Hill Primary School Study, found that air pollution levels on the back streets, including pedestrian only paths across the housing estate were lower than those measured on the main roads. Margaret used the data to argue to the council officials that if these pedestrian paths were closed, residents would be forced to walk along the main roads, therefore, increasing their exposure to pollutants. Similarly, one of the parents interviewed highlighted that the data collected by the children was valuable 'evidence' that should be presented to the council, to be taken into consideration when trying to close some of the local

roads as an effort to reduce air pollution hot spots. She was particularly concerned about the recent council proposal to close some of the main roads in order to discourage drivers from entering this area of London and forcing them to find alternative routes outside the borough. She explained that closing the roads would only force cars to go through the, until now, quiet estate where she lives (Varaden et al., 2018).

8.4.2 'Industry also has a role to play'

The role that the industry has in helping to tackle the air pollution problem in London, was also highlighted, particularly by the Breathe London Project participants. They argued that companies could and should make sure that their workforce have the right information, advice, infrastructure and incentives, so they can adopt environmentally friendly actions. This would not only benefit their employees personally (e.g. reducing exposure by walking on the back streets) but also actions which would contribute to the lessening of air pollution in the city (e.g. cycling to work instead of driving). For instance, if a company is encouraging its employees to cycle to work, they should also make sure they have the right provisions to park their bicycles securely. The following extract illustrates.

> *"The problem is, it's just keeping the momentum going. So, for example, if we take this building, for example, last year they expanded the cycle parking in the basement. So they expanded it by about double. Now, when you go there, almost every parking space is taken up because it's encouraged so many more people to cycle to the office, that they're now running out of space. And the problem is, if you get to that point where there's nowhere to park your bike, it does put people off. So, I had that problem on, even on this week, on Monday or Tuesday where there was no space. And I had to actually take my bike out of the building and park it two blocks down the road because they'd run out. So it's good that they are expanding, but it's almost like they need to keep that momentum and keep expanding".*
>
> *Lawrence, cyclist, Crossrail, BLP*

Lawrence also commented that he not only uses his bicycle to get to work but also to carry out work related visits across London as part of his daily work routine. He felt he was not being encouraged and or rewarded for his "greener" choice of transport. He indignantly explained that his colleagues, who used a car to move across London for work related activities, were given allowances per mile driven to cover for the fuel and or wear and tear of the vehicle. However, he was not receiving anything for his physical work (the fuel) and, or, for the wear and tear of his bicycle.

Participants' views in regard to the industry's role in tackling the air pollution problem were also gathered at a more senior level from one of the companies approached as part of the BLPs interviews. In the following extract, Kate, Investec employee and active player in the 'Air We Share Campaign', talks about some of the measures her company has taken to address the air quality problem, not only inhouse, with its own employees, but also by adopting measures which could generate bigger impacts.

> *"Well I think we need to show that we do care for our people and that we are telling them what to do and what not to do about air quality for them on a personal basis. We also need, and we have, gone to our taxi provider and told them that we only want to use cleaner cars. And currently we have a black cab – of which there is no alternative to black cab at the moment – and also, they're given preference because they can drive in lanes that other taxis can't. So that also could be changed. And with the cars, with the kind of executive cars, they only provide a diesel driven Mercedes. And because we were on to them, and other companies were on to them, they are changing from January next year – they're only going to have a clean Mercedes fleet, which is – that's where we need to be, sort of from every angle from the individual to the – what we can do as a corporate. And the influence we can have on changing what is happening on the road".*
>
> *Kate, Air We Share Campaign. BLP*

Other measures reported to have been adopted by one of the companies involved in the BLP in order to tackle air pollution included: a) requesting suppliers to provide machinery with low emissions, which encouraged suppliers to 'play catch up" with what they can offer and what the client is requesting. And b) exposure assessment studies for company employees in order to identify ways in which their exposure to harmful pollutants could be reduce while at a work site.

8.4.3 Communicating and engaging through participatory interventions

Participants across all groups mentioned that in order to communicate air pollution to the public in an effective manner, engaging, innovative and holistic approaches should be used. Participants across all groups highlighted the value of using participatory research approaches such as the one used in this study, where community members had the opportunity to carry out their own personal exposure monitoring. Participants felt that such approaches can help to raise awareness about air pollution and also, they have the potential to trigger changes in practice in order to reduce exposure. The following extract illustrates this.

"I think it would need a kind of change in the models for tackling it, that the public health officer has. So they tend to think in terms of immunisations or leaflets, public information campaigns. But actually, to deal with this would need a whole kind of package of cycling and walking group members, and lobbying, and TFL, so it would cut right across the local council. So I think it's, they see it as too complicated and without boundaries as well. So, you know, "What can we do? We could spend all this money and we wouldn't see any benefits." But I guess, you know, this kind of research about reducing exposure shows that you could have immediate benefits for individuals before you even get to reducing the absolute levels".

Margaret, The Dog Kennel Hill Primary School Study, BLP

Participants from the COPD group also noted that information (personal air pollution exposure data) such as the one collected through the air pollution monitoring exercise, should be used to inform policy making and should be taken into account when developing future interventions. Although most participants agreed that participatory research interventions like the one conducted in this study were a good way of engaging with people and communicating air pollution, they also suggested that they should be linked to other activities of similar nature (e.g. other community projects), so they can be presented to decision makers in an organised and meaningful way. Participants argued that efforts to communicate air pollution should be joined up as opposed to having many initiatives and/or organisations working in isolation delivering different messages, in other to meet their own agendas.

"I think so, I think so, because the problem is, and nobody believes politicians anyway, and if they – if someone says, 50,000 people die from lung pollution, it's really like a religion, you either believe it or you don't believe it. And you can so easily just dismiss that because if you're not suffering from a lung condition, or your children aren't, then you think, "Oh well, that's just a statistic, they're trying to frighten us," rather like the statistics they're bandying about now about whether we should leave the EU or not, you know. It's all done through politics of fear and so on. And so, I think there will be a problem in getting this across to people"

Mr Woods, SCG

Similarly, parents and children from the primary school project, highlighted that it would be valuable if projects like the one conducted in this study were part of their children's science lessons. Participants highlighted that it was important to keep the children engaged and to remind them on a regular basis about the a) sources of air pollution, b) health effects of air

pollution and c) the different things children and parents could do to reduce exposure to air pollution, such as driving less to school and encouraging active travel.

> *"Remind them in assemblies, have posters up around the school, umm show them how much more fun it is to walk, and to ride a bike rather than to use um public transport or, you know, ask them to talk on a regular basis with their parents.*
>
> *Bianca, (Aleena's mother), Primary School.*

Although the common consensus across all community groups was that people needed to be made aware of the dangers of air pollution, participants also highlighted that careful consideration should be given to the information conveyed to the public. They considered that messages should be clear and consistent, particularly highlighting the things that people could do reduce their exposure to air pollution.

> *"There is just so much you're being told. And the thing, I mean certainly with the dietary thing is an example where they'll tell you one thing one week and something another week. It's not a clear message. I think certainly if there's an air pollution message, it has to be clear and consistent, because otherwise it turns people off".*
>
> *Betty, SCG*

During my fieldwork, I observed that although, in general, participants seemed to have a certain level of air pollution awareness, there was still little understanding about how best they could a) contribute less to the air pollution problem and b) how they could reduce their personal exposure to air pollution.

Discussion

In Chapter 6, I showed that participatory research, where community members had the opportunity to carry out their own personal exposure monitoring, was feasible and could be used as a tool for communicating air pollution to the public and for encouraging changes in practice in order to reduce exposure. However, to engage with the public and develop fruitful policy interventions aimed at tackling the air pollution problem, it is important to take into account people's perceptions of air quality issues (Slovic, 1987) as this will ultimately determine the most effective course of action.

I have argued that that there are several factors that could influence the way people perceive air pollution and associated policies (Slovic, 1999) (e.g. if participants owned a car or not). While some participants were more inclined to show support for policy interventions that

targeted the behaviour of others but not directly their own, some participants also highlighted that in order to achieve improvements in air quality, a combination of strong political commitment and people's acknowledgment of the problem and changes in own practices was essential. During this study, participants' views on the topic of air pollution were largely influenced by the events taking place during that period of time and which were highly documented by the media. Therefore, this suggests that the media may have acted as a social amplification station (Kasperson et al., 1988), making these events (e.g. diesels gate) an important and common topic of conversation (Kenis, 2017). This could also explained why while participants were not directly asked about policy and or policy interventions, this was a topic that came up frequently in conversations.

This study suggests that the government's perceived failure to deal with the air pollution problem has had an effect on the level of the public's trust towards policy interventions that aim at tackling the issue of air pollution. Some of the narratives gathered by the participants showed a sense of frustration and alienation. Participants felt that they did not have any power on influencing the decision making process. Participants' views particularly in regard to government policies to persuade the public to buy diesel cars, which resulted in increases in NO_2 and associated health problems and the diesel gate scandal, have sprouted a lack of trust in institutions. Throughout their narratives, it was possible to sense that the participants were demanding transparency and accountability. Furthermore, it seems that the emphasis given to negative outcomes, such as the one described by Mr Woods earlier in the chapter "*50,000 die from lung pollution"*, which are common in air pollution discourses and media headlines, may terrify those who are at risk (e.g. the mother from P&BG who intended to cross the traffic lights in red to avoid exposure to air pollution while waiting at the road crossing with her children – Chapter 7). The negative outcomes may also be completely disregarded as the public become unresponsive to frightening statistics. The ethical implications of this approach to risk communication, where anxiety and guilt are placed upon the public have been questioned (Lupton, 1993). This can have important consequences for the planning and delivery of policy interventions as an unsympathetic and or unresponsive society could jeopardise the leadership capabilities of those in power and the success of policy interventions (Bates, 1975).

The findings from this study showed that communicating air pollution risk to the public is essential not only to encourage people to reduce exposure but also to inspire people to think about how they can contribute less to the problem. I argued that, if people understand the risk posed by air pollution, they would be more likely to support and adopt policies aimed at tackling the issue. Furthermore, access to personalised data gathered from the participants local surroundings had also highlighted the multiple air pollution sources that can be found

within local neighbourhoods (e.g. construction sites, vehicles, shipping etc.) This highlights the importance of understanding and addressing holistically the different sources of pollution which together make up the whole picture.

However, strategies to communicate air pollution risks are likely to be ineffective if people do not trust the source of information (Slovic, 1999). Furthermore, the public's ability and willingness to uptake knowledge is linked to the level of trust and confidence individuals have towards science and its representatives (Wynne, 1992). It has been argued that the trust that people have in science and their representatives, can be boosted by not only telling them about science but also by allowing them to take an active part in the research process (Corburn, 2005). The results from this study showed that information about air pollution could be conveyed to the public through air pollution monitoring projects where members of the public have the opportunity to be actively involved in the research process and where citizens are able to "see" the extent of the air pollution problem in their own neighbourhoods.

Throughout this study I have shown that giving people the opportunity to be part of the research process (conducting the science), gathering their own data and identifying by themselves what they are likely to be exposed to while they go about their normal lives, has the potential to raise awareness of the issue. This in turn can lead to changes in practices to reduce exposure to harmful pollutants. Self-collected data (evidence of the air pollution problem in the local surroundings) has also the potential to highlight the extent and urgency of the problem and the imperative need for tackling the issue. Therefore, potentially encouraging people to be more supportive of polices that aim at tackling the problem.

Chapter 9 - Discussion and conclusions

Introduction

This study highlights the importance of interdisciplinary work bridging exposure science and social science disciplines using a range of research methods from both disciplines. It presents the benefits of involving lay individuals in the research process, gathering their own exposure data using modern wearable technology. It provides public health policy makers with valuable information in regard to new engagement and communication methods for delivering more efficient and effective interventions.

In this thesis, I provided an empirical and critical account of a participatory research approach through the implementation of participatory air pollution monitoring projects across a range of community groups. Tracing participants' experiences and perceptions of taking part in these participatory research projects allowed me to present a case that illustrates how participatory air pollution interventions are carried out in practice and in different settings. The detailed descriptions of how these interventions were conducted, and of participants' experiences contributes to our understanding of the feasibility and effectiveness of using this approach as a tool for engaging the public in air pollution.

In this chapter, I return to my research questions outlined at the beginning of this. This chapter, is therefore, both a summary of the findings and a discussion of the implications of the findings. I also offer a reflection on the challenges of adopting a participatory research approach, on the strengths and limitations of my study, and on the methodology used. I end this chapter by highlighting the broader implications of this thesis for air pollution policy and public health.

9.1 Summary of findings and contributions to knowledge

To start this PhD, I conducted a scoping review of the literature in order to set the stage for this research. In Chapter 2, I provided an overview of the literature in regard to public perceptions of air pollution. It was clear from this chapter that while air pollution had certainly become more of a topic of discussion among a range of stakeholders, and government efforts to tackle the issue were increasing, there was still the need to develop methods which could aid the communication of air pollution among the general public. However, the question of how we could communicate air pollution to the general public remained. In Chapter 3, I

explored the concept of participatory research (PR) and I identified that, while this approach has been used extensively in the air pollution field, predominantly in unpublished work by NGOs and similar charitable or community groups, there was still a lack of systematic empirical evidence on the feasibility of using this approach with a range of individuals, and on the impact on participants' views of air pollution.

This study aimed to further contribute to this body of literature by providing empirical evidence on how individuals from a range of community groups conducted their own air pollution monitoring research, on the impact that this approach can have on participants' perceptions and practices, and on the potential of PR as a tool for communicating air pollution as a health risk and developing strategies to improve the local environment and public health.

The research question underpinning this thesis is: Can community-based participatory research interventions, which involve the collection of personalised data, be used to aid the development of effective methods of engagement with community groups to improve the local environment and public health? In order to conduct the research in a more step-by-step manner, I formulated three sub-questions which are addressed in my three result chapters and summarised and discussed below

9.1.1 A participatory research approach to air pollution monitoring

What motivates people to take part in participatory research which involves the collection of personalised data? And, what are the views and perceptions of those who take part in regard to their own project outcomes, expectations, interpretation of the data and further use of the findings?

I conducted four participatory air pollution monitoring projects with members of four community groups across London (Primary school, parent and baby group, senior citizens group and, a Chronic Obstructive Pulmonary Disease (COPD) patient group). The research undertaken was empirically novel in terms of the variety of groups investigated and the unique characteristics of the study design employed. The members of each of these community groups participated in an information session on air pollution causes and effects, then using portable exposure monitors and GPS watches, a subset of participants from each group measured the air pollution they were exposed to as they went about their normal day. The impact that this participatory research approach had on participants' views and perceptions towards air quality was assessed using a range of qualitative research methods (observation, interviews and surveys). I also examined the views of a number of individuals from the Breathe London Projects in order to assess the impact that similar approaches to research have on the views of those who have, on their own accord, proposed and carried out similar air pollution monitoring

initiatives. Conducting these PR projects in different community settings and gathering the experiences of the BLPs participants allowed me to explore the extent of the impact that PR approaches to air pollution monitoring can have on different members of the community.

In Chapter 6, I showed that participatory research methods can be implemented in practice and they have the potential to be effective and engaging tools for raising awareness of air pollution as a health risk amongst communities by supplementing information provision with active collection of personalised exposure data.

The PR approach used in this study gave participants the opportunity to be part of the research process in different ways and at different levels (e.g. planning their monitoring, interpreting the data, disseminating the findings). I examined participants' motives for taking part in PR interventions and I showed that while gathering knowledge seemed to be the main reason as highlighted in the literature (Rotman et al., 2014, Land-Zandstra et al., 2016, McCrory et al., 2017), the underlying reasons for gathering this knowledge varied according to people's backgrounds and personal circumstances.

This study has made a distinctive contribution in relation to distinct knowledges that emerge as relevant forms of awareness for different participant groups and for different purposes. "Knowledge to safeguard future generations" was characteristically sought by senior citizens and by the parents of young children, while "knowledge to safeguard self" was typically sought by the COPDG participants who wanted to know more about potential sources that could exacerbate their symptoms. There was also 'knowledge in it is own right' commonly pursued by those participants whose social contexts involved a learning environment (e.g. school children and senior citizens members of the U3A). Other forms of knowledge that emerged were 'knowledge to assess the local magnitude of the problem' sought by local residents across all groups and 'knowledge to build evidence to advocate for change', mainly pursued by environmental campaigners and community leaders.

In Chapter 6, I also highlighted the value of gathering own personal exposure data. I explored the participants' data expectations and whether these were met. I showed that although there was an explicit inclination to associate air pollution with traffic, the personal nature of the measurements gave participants a sense on the magnitude of the problem in their own surroundings. I showed that self-collected air pollution measurements made the participants' data relevant and meaningful, and that this translated into different forms of action such as: the adoption of personal air pollution reduction exposure measures, a desire to influence others (family and friends practices), changes in political choice (supporting candidates with green agendas) and in some instances encouraging advocacy. While the data gathered was of personal nature, having access to this data, also influenced some participants to act as a group

to take action to improve their environment. A clear example of this is the proposed anti-idling campaigns by the primary school children)

9.1.2 Air pollution a health risk: From understanding the risk to taking action

How do people perceive and understand the risks posed by air pollution? And, how can the perceived risk be communicated using a participatory approach to research?

Having access to a range of community groups gave me the opportunity to explore how people perceived and understood the risk posed by air pollution. In Chapter 7, I explored two important contributions to risk research: Cultural Theory of Risk (CTR) (Douglas & Wildavsky, 1983) and risk society (Beck, 1982). The former provided me with some interesting insights into people's attitudes towards risk, on how risk can be culturally dependant and, therefore, understood in different ways by different actors. Beck's (1982) theory of risk society provided a framework for understanding how risk can be conceptualised and guided my thinking about air pollution as a risk in modern society. In Chapter 7, I showed that while air pollution is a modern risk which is largely the result of human activity and which can affect us all (Beck 1982), there are certain groups within society which can be more at risk of air pollution (e.g. those who have worse health conditions). Beck also stressed that given the complexity of modern risk, calculating and addressing risk is confined within the boundaries of scientific knowledge and expertise (Beck, 1982). My views in this regard tend to differ from Beck's views. I argued that the risk posed by air pollution can also made visible by lay people through participatory research interventions, gathering their own exposure data. Furthermore, I showed that, by gathering this data, participants were able to help interpret the results and explore strategies for addressing the issue. I showed that some of the barriers for communicating air pollution as a health risk are inherently linked to circumstances in which people lived their lives which created feelings of powerlessness, compliance and detachment. Furthermore, I showed that while participatory research had the potential to increase air pollution awareness among the general public, there might still be constraints which could limit the extent to which people were willing to change practices in order to reduce exposure to air pollution. I argued that changes in practices may be subject to how people rank the severity of the risk compared to other risks and, or priorities which they may consider greater or more imminent.

During this study, all participants who took part in the air pollution measurement received personalised reports of the data they collected. The air quality data recorded while the participants were in motion (walking, biking, or in a vehicle) was presented to them using graphs, tables and maps. I showed that the use of maps, showing participants' whereabouts

while they were carrying out the air pollution monitoring with colours highlighting the levels of air pollution along the routes, were effective communication tools. There is evidence that complex scientific findings can be understood by lay individuals if communicated appropriately and that the participation of lay individuals in the production of scientific findings can lead to individual and collective actions that may have a positive impact on the community livelihoods (Adams et al., 2011, Jasanoff, 2014). The maps helped participants to identify their surroundings, major roads and intersections. The use of a colour scale permitted participants to see the different levels of air pollution encountered along their routes and to compare results with other participants. This was particularly useful as Black Carbon (BC) (the pollutant recorded) does not currently have any health guidelines or limits. Therefore, participants were encouraged to interpret their results through comparison, for example low concentrations (blue) measured on the back streets against high concentrations (red) normally measured on the main roads and junctions. Participants also received a table indicating the average BC exposure for each of the activities reported by the other participants in the group (e.g. while at home, when commuting, etc.). This was done following the feedback from one of the participants from the P&BG, who argued that to further understand her findings, it would be useful to know what was "high" and what was "low" so she could assess her findings (levels of pollutant recorded) in relation to those of other participants from the same neighbourhood.

Communicating the findings back to the participants seemed to have had a positive impact on the participants' overall awareness and understanding of their personal exposure to air pollution. However, it is important to consider that there can be benefits and harms from receiving information about air pollution exposure. To reduce the adverse effects that having information about personal exposure to air pollution may have on the public, it is important that this information is coupled with key messages and resources that can helped people to reduce their own exposure to harmful pollutants.

It is also important to highlight that given that each individual or community group has its own particular needs, the reporting back process can be overwhelming for the researcher as the reports have to be tailored to specific settings and social surroundings. People are always situated in a social setting, which has to be considered when trying to explain people's understandings, feelings and practices. (Lidskog and Sundqvist, 2012).

9.1.3 Perceptions of air quality policy and their impact on communication interventions

How do people who take part in participatory air pollution research perceive air quality policy and how can this impact policies to tackle air pollution?

In Chapter 8, I shifted my attention away from how participants perceive air pollution risk and how these perceptions are impacted by adopting a PR approach to how they perceived air quality policy and the potential impact of PR on the development of policy interventions and community engagement. In Chapter 5, I presented the extent and nature of air pollution coverage in the media over my period of fieldwork, Kennis (2017). In Chapter 8, I highlighted that there were associations between themes identified in Kennis's study and the narratives gathered from the participants. I showed that discourses changed over time and can be highly influenced by local events and by how much these events are portrayed by the media, thereby, acting as a social amplification station (Kaperson et al.,1988). I showed that by taking part in the participatory research projects and gathering their own air pollution exposure data, participants not only increased their awareness and understanding of the issue, but also raised questions about responsibility and accountability.

Most participants in general showed their discontent with the air pollution panorama and the way the government was handling the problem. However, the active process of collecting evidence of the magnitude of the air pollution problem in their local area inspired some participants to propose actions to tackle the issue at a personal and at a community level (e.g. idling campaigns). This, I argued, was of particular importance as the effective implementation of policies ultimately depend on the public's acceptability and support. People might feel more supportive of government initiatives if they were given the opportunity to be part of the research process.

Having summarised the outcomes of this research, I will now discuss the wider implications of these findings.

9.2 Conducting participatory research

From the outset of my doctoral candidature, it was clear to me that my research would require the active participation of diverse members of the community. However, my knowledge about participatory methods was rather limited and the difficulty of precisely defining the various existing participatory approaches made the task of identifying a suitable methodology rather challenging. After finishing the three months of social science research methods and exploring the literature on participatory approaches, it became evident that given the precise and unique characteristics of my study design, I would not be able to label the proposed project methodology under the current participatory research approaches highlighted in the literature (e.g. Citizen Science, Community Based Participatory Research, Participatory Action Research etc.,). Therefore, I decided to let my research be guided by the participatory research key principles influenced by the Brazilian educationalist Paulo Freire's work in education as highlighted in Chapter 3.

In contrast with conventional, linear approaches, where clear action plans are developed and followed, the projects conducted throughout this study developed in different ways where the agendas, interests and values of each of the community groups were driving the interventions. Interventions where members of the public are involved are generally challenging, and they tend to be more so when members of the public are invited to take an active role in the research process. The more 'participatory' the intervention is, the more difficulties the researcher is likely to encounter (Cornwall and Jewkes, 1995). The air pollution monitoring projects conducted during this thesis followed a 'collaborative mode' (Green, 2009, Cornwall and Jewkes, 1995, Bonney, 2009) where the initial research question of "How much air pollution are you exposed to as you go about your daily routine?" was asked by the researcher while the public collected the data to help answer this question, drew their own conclusions and disseminated the results with other members of their communities. This section highlights the main practical challenges encountered and the lessons learned when conducting participatory research interventions with a variety of community groups across London.

Participatory research as a research-degree student

As a research-degree student from a natural science background, attempting to conduct participatory research for my PhD, I encountered a number of challenges. First, in order to comply with my academic requirements and to obtain the required ethical approval to initiate my study, I had to design a protocol before I started my fieldwork and contacted the participants. Therefore, even though I tried to conduct this study in a participatory way as much as possible, some elements of the study were designed without the input of the participants. For instance, the air pollution education session (introductory talk), which was the first element of the projects. Perhaps, if I had the participants' involvement in the designing of this talk, I would have presented other topics which may have been equally or more interesting for the participants. However, participation can occur at different levels and in different ways (Pain and Francis, 2003). For example, during this study, some participants from the senior citizen group helped me with the logistics of organising the project for their group, while others disseminated the findings of the monitoring project through their social channels (newsletter). In the primary school, children were active voices at disseminating the project findings, while the involvement of most COPDG participants in the project was mostly limited to gathering the data. Second, participatory research has been characterised by its time-consuming nature (Israel et al., 1998, Cornwall and Jewkes, 1995). During this study, a greater investment of time and effort was needed. For example, although giving each participant a feedback report was a key part of my project, it was also a very time-consuming task as I had to prepare each individual report and meetings had to be arranged to suit each person's schedule.

I was open with participants that I would benefit from their participation by completing my doctoral thesis. This motivated some participants to take part in the project as they wanted me to achieve my academic goals, although this was not formally captured. It has been highlighted that post PhD, graduates can benefit from having acquired a wider set of skills and competencies than just specialised knowledge in a given topic (Melin and Janson, 2006). Adopting a participatory research approach, working with the people and immersing oneself in various community settings, although challenging at times, can aid with the gaining of many of those valuable skills.

The lessons learned

The purpose of this section is to highlight some of the difficulties I encountered when using participatory research in this study as well as the lessons learned in the process. This may be useful to those who intend to use the PR methodology.

As previously highlighted in the literature, it is critical to the success of a participatory research intervention to identify and engage with a community 'leader' (Israel et al., 1998), who can help engage with participants, and deliver the proposed intervention. During this study, the gate keepers were also the community leaders. These individuals not only allowed me to conduct the projects in their communities, but they also gave me full support throughout each stage of the intervention. For example, Mrs M, deputy head of the school arranged the required logistics for accessing the school and meeting the children, helped to select the monitoring team and gave recommendations about the amount and level of complexity of the information to be given to the children. This highlights the value of having the support and commitment of gatekeepers when undertaking this type of interventions. Having the support of these community leaders was key for the successful completion of each of the projects. However, it should be highlighted that the fact that although I was controlling the research strategy and setting up agendas, I had to ultimately depend on participants to carry out or not the proposed activities.

Participation goes beyond just taking part, it involves playing an active role during the research as well as taking decisions and implementing actions (Rifkin, 1990). Soon after I started my fieldwork, it became apparent that some participants were expecting to benefit from taking part in the proposed projects beyond the satisfaction of doing it for the 'greater good'. These participants were presenting signs of what has been described as "research fatigue". It has been suggested that "research fatigue" can be caused by a number of reasons including lack of perceivable changes attributable to taking part in the research, having taken part in research already and practical causes such as cost, time and organisation (Clark, 2008). Most of the

community groups that took part in this thesis research, have been approached in the past by governmental and or academic institutions which gathered the data they needed (e.g. asking participants to fill in surveys) without offering participants concrete benefits for taking part.
These previous experiences had made some participants cautious about taking part in research projects. Some argued that researchers were only using them as sources of data. These intrinsic perceptions towards research and researchers made some of my engagement work more challenging than initially expected. However, as part of using a participatory research approach, I acknowledged and addressed people's requests for beneficial projects outcomes. For example, participants were made aware that they would be collecting their own personalised air pollution data and would have access to the results. I also highlighted that information about how to reduce their exposure to air pollution based on their results would be provided. Throughout these projects, I was not only a "researcher", I was also an 'actor' evaluating my own participation and implementation of planned schedules.

The practicalities of arranging each of the projects and the need for flexibility were some of the common challenges I encountered during fieldwork. For example, at times, and for various reasons, participants were not able to attend the planned meetings (e.g. COPDG participants were unwell, P&BG participants had last minute commitments with their children etc.). These changes in the pre-arranged schedules had an effect on my timetable. Conducting participatory research, where members of the public are involved, required flexibility regarding commitments and time schedules in order to sustain participant involvement. This is particularly important as the time and resource intensive nature of participatory research approaches could discourage its use.
Relating and being sympathetic to participants' lives and, or, priorities proved to be important for developing a strong relationship. For instance, during my fieldwork, one mother arrived to the scheduled appointment (to pick up monitor) one hour late because she was taking her baby to have a jab and the baby was a bit unsettled afterwards. Having done numerous jabs and doctor's appointments with my own son, meant that, I could relate to her immediate worries and priorities, and even provide some 'mum to mum' advice. After acknowledging the things that at the time mattered the most to her, we had a friendly conversation about the project and the next steps regarding the monitoring.

Dealing with different socio-cultural settings was also challenging. My fieldwork involved working with children, parents, pensioners and people with health conditions. Having such a range of participants meant that, I could not have a 'one size fits all' strategy which I could use across all groups. I had to not only develop different engagement materials for each group

(e.g. introductory talks) but also to develop strategies for communicating effectively and amicably with each of these communities.

Using a participatory research approach gave me the opportunity to establish a two-way communication process whereby participants were able to express their views regarding how they thought it would be best to present the findings and what sort of information should be included in the feedback reports. I learned that offering participants the opportunity to see other people's results helped them contextualise their own, particularly in the absence of regulatory pollutant benchmarks. Although, providing participants with their personal air pollution exposure, comparisons to their local community, and advice to reduce exposures were important components of this PR study, this approach presented methodological and logistical challenges, given its time and human resources demands.

9.3 Strengths and limitations of my study

There is scant empirical evidence regarding the impact that personal air pollution exposure data gathered through community-based interventions can have on those involved in the process. The impact that air pollution participatory approaches can have on participants has been explored in studies which mostly involved static and, or passive air pollution monitoring rather than personal exposure monitoring (Commodore et al., 2017). There is a lack of evidence regarding the impact that participation in air pollution interventions which involved the gathering of personal exposure data have in the way people view and perceive air pollution. This study contributes to understandings of awareness and perceptions of air quality by revealing the inner experiences of a range of community group members who took part in air pollution monitoring projects where personal air pollution exposure data was gathered.

Over a period of two years, over 50 hours of participant observation fieldwork were conducted and sixty-three participants were interviewed across a number of community groups in London. This yielded a large quantity of data from a diverse range of sources. Whilst this was intended to enable the capturing of experiences from a variety of individuals, it restricted the opportunity for in-depth analysis of any single community group. During the data analysis, it became apparent that the views and perspectives did not only vary across groups but also across individuals within these groups. While I endeavoured to highlight these differences when this seemed pertinent, further exploration of the different views and perceptions between participants was beyond the scope of this study. Similarly, while a variety of participants were involved in these air pollution monitoring projects, it was not possible to assess participants in terms of demographic and other characteristics making it difficult to generalise about who participates in such projects.

Additionally, data analysis was complicated by the fact that there were many different views and feelings about the topic. Therefore, while analysing the data I had to bear in mind that certain views could be held by only one person and were therefore not representative of the community group. While these conflicting perspectives presented challenges when analysing the data, this was also a strength of the study design as this allowed me to recognise that participants' views and perceptions towards air pollution are varied and hence air pollution communication strategies may also need to be designed in a variety of ways.

During this study, the changes in practices and, or behaviour of participants were not measured objectively, thus, I was limited in my ability to assess and draw conclusions with certainty about whether participation in the project(s) led to sustained changes in practice or perceptions. Surveys were conducted before and after the projects took place at each of the community groups. This was to assess changes in participants' views and perceptions towards air pollution as well as changes in practices as a consequence of taking part in the projects. The surveys conducted were completely anonymous and hence it was not possible to analyse repeated responses for those who responded to both pre and post survey. Furthermore, the dynamic nature (high turnover of group participants) of most of the groups meant that some of the participants surveyed before the project, were not necessarily the same participants surveyed after the project took place. Therefore, my discussions on changes in practices is based on what participants told me through informal conversations and interviews sometime after they have received the report with the summary of their project findings. Repeating these interviews at a later stage when the proposed changes are either more embedded in participants' daily lives or completely elapsed would allow a more robust assessment of the impact of the approach in the long-term.
Finally, it should also be acknowledged that the self-reported nature of the surveys may have led participants to respond according to their idea of what the researcher and /or the teachers (for the primary school project) were expecting from them.

Similarly, while it may seem obvious that opting for practices that could lead to a reduction in air pollution exposure are beneficial to people's health, there is not enough evidence on the actual health outcomes after changes in practices for reducing exposure have been adopted. Therefore, new forms of uncertainty arise, and the need for further research to address these uncertainties is emphasised.

During this study I was very conscious of the potential for bias given my background as an air quality scientist. I attempted to addresses this by highlighting the instances where my position

as the ‘expert’ (e.g. when asked for advice and, or my opinion about air pollution related issues) could have influenced the participants’ views on the topic. Furthermore, I am also conscious that my commitment to and passion for the project might also have introduced an element of confirmation bias. The empirical data gathered could have been interpreted differently by others, paying greater attention to different aspects of the participants’ narratives. In order to address these concerns, I discussed my work-in-progress with others at different stages of the data analysis. This included regular discussions with my supervisors and presenting findings at departmental seminars. I also received valuable feedback by presenting at national and international conferences and seminars delivered to a range of community groups not involved in this study. I am confident that the conclusions I have drawn are well-founded and rooted in the empirical data gathered and contextualised by theory and relevant literature.

Despite this study’s specific focus, the findings resonate strongly with topics such as risk perception, risk communication and science communication which are all topics relevant to a wide international audience of social science researchers, air quality scientist and policy makers.

9.4 Reflections on the methodology

During this study, I used two different methodological approaches: ethnography and participatory research. The former was used as a data-gathering methodology providing insights into participants’ experiences of taking part in the air pollution monitoring projects. The latter was used to get community groups involved in the design, implementation and dissemination of their own air pollution monitoring projects. The aim of employing these two methodologies was to shed light on how people understand and perceive air pollution, and on how community-based projects impact people’s perceptions and attitudes towards air quality issues. In this section, I critically reflect on the use of ethnography as a tool for gathering data when conducting participatory research.

My interactions with social scientists through journal and writing clubs, seminars and conferences have been of great importance for evolving my thinking about the need for viewing and addressing societal challenges, such as air pollution through an interdisciplinary approach. I found the use of ethnography a particularly stimulating and enriching experience, which took me over the boundaries of what I considered to be scientific research. Through the use of ethnography, I was encouraged to reflect on the process as it took place, this was particularly useful given that I found participatory research is essentially an organic process that need to be evaluated and re-thought while in the making.

Some researchers will be somewhat sceptical about the robustness of ethnographic field work which has not been carried out over long sustained periods of time (Howell, 2017). However, I agree with the views of Jeffry and Troman (2004) as highlighted in Chapter 3, who argued that there are different forms of ethnographic research time (e.g. recurrent time mode). During this thesis, I documented my field notes at each of the project(s) stages (e.g. during the recruitment, the air pollution monitoring and the results feedback sessions). While I was not continuously immersed in the community settings, adopting an ethnographic approach allowed me to gain valuable information about the experiences of individuals within their socio-cultural settings while carrying out the air pollution monitoring projects. Ethnography also gave me the opportunity to explore participants' practices, discourses and own interpretation of events, and to examine why people did and said particular things, rather than what they said they did (Hammond, 2013 O'Reilly, 2009) (as I might have recorded with interviews alone).

By combining PR and ethnography, I was, to some extent, evaluating my own role in the project, where my participation was very much as an expert, contrary to conventional ethnography where the researcher is positioned as a non-expert and whose role is to learn about being in a particular group. Through the use of ethnography, I was able to reflect on my position as both insider and outsider. My insider knowledge and expertise in air pollution were seen as an asset by many participants who were keen to establish conversations and share their thoughts with me. My position as an outsider was not as strong and marked as the insider position, and it was mostly apparent on commencing my fieldwork, while first approaching the community groups and, or participants. As an outsider, I had to gain access to the community groups, which in some settings such as the Parent and Baby Group enabled me to identify the issues surrounding peoples' views towards participation in conventional research.

While ethnography offered benefits for my study, there were also specific limitations particularly regarding my active participation in the project, this limited my gathering of notes, which most times had to be made from memory based on my own interpretation on how the events took place. It should also be highlighted that, while emphasis on participants' local contexts and their experiences can enrich the data gathered and its analysis, the specific focus, informal methods and non-random samples that characterize the participatory and ethnographic approaches can limit their replication and, or the generalization of the findings (Roncoli, 2006).

This study have shown how that by integrating natural science (exposure science) techniques with social science research methods (qualitative methods) in an interdisciplinary fashion, we are able to better understand the complexities surrounding people's personal exposure to air pollution and their own understanding and perception of the problem.

9.5 Recommendations and implications for future policy and research

While the motivation of this thesis was not to formulate policy solutions to the air pollution problem, this research was conceived partly in response to the need of developing strategies to engage with the public to communicate air pollution and therefore, the conclusions of this thesis contain some important points relevant to policy.

Advances in air pollution sensor technology offer members of the public, the opportunity to monitor air pollution levels themselves using relatively low-cost, accurate and straightforward portable equipment. This study identified that with suitable technical support, portable air pollution technology offers the potential for communities to carry out their own air quality monitoring projects around schools and neighbourhoods. The wider use of low-cost sensors can make air pollution monitoring possible at many more locations, improving air pollution exposure and health assessments. This in turn can improve our ability to better understand air pollution and to develop effective air pollution prevention strategies.

Participatory research approaches have the potential to complement the provision of information which on its own seem to be insufficient to change practices. However, while raining awareness it is a fundamental part of the process, it is clearly not the entire answer for encouraging effective and long term changes in practice. It is also important to provide individual's with clear actions (measures) that can be adopted in order to reduce exposure to harmful pollutants. This study showed that playing an active role in the research process and gathering their own air pollution exposure data permitted participants to appreciate the magnitude of the problem. While this understanding may have led many participants to question the effectiveness of policies aimed at tackling the air pollution problem (e.g. taxes), it had also helped participants to acknowledge the importance of addressing the issue. This, in turn, could encourage the support of local policies that aim to remediate the issue.

The empirical evidence gathered from this thesis has the potential to contribute to understandings on the acceptability, engagement and impact that participatory research methodologies which involve the collection of personalised air pollution data can have on the general public. The outcomes from these projects can be used to inform local administrators and public health officers on the development of strategies to engage with the public to communicate air pollution.

This study showed that people's views and perceptions of air pollution risks are varied and dependant on many socio-cultural factors. Therefore, suggesting that the "one size fits all" approach to engagement and communication, may not be effective. Engagement and

communication strategies should be tailored to specific groups, taking into account their needs and expectations.

In this thesis, I have shown that participatory research is feasible and has the potential for raising awareness and encouraging changes in practices. However, further studies are required to gather empirical evidence on the longevity of the adopted measures. Future studies should also gather evidence on the actual health outcomes after personal measures for reducing exposure have been adopted, as this will ultimately determine the effectiveness of the adopted changes.

9.6 Conclusions

Participatory research approaches which involve the active collection of personal air pollution exposure data can be carried out successfully with members of the public from a range of community groups. Personalised exposure measurements give individuals the opportunity to find out what they are exposed to as they go about their daily lives and access to this information have the potential to boost their level of air pollution awareness and hence, their understanding of the issue. This study has shown that through this understanding, members of the public can have the opportunity to analyse their own situations (e.g. places and times where they were most likely to be exposed to air pollution) and to propose solutions to reduce exposure to harmful pollutants and or reduce their own contribution to air pollution. Access to results from personal monitoring interventions has also the potential to empower some individuals inspiring them to take action to advocate for better environmental conditions (reduction on air pollution) in their neighbourhoods.

This study also highlights that not only those who are already politically active or environmentally aware can be actively involved in research, but 'ordinary' citizens can also collect their own data and thus produce new knowledge to improve their local environment and personal well-being. I have shown that adopting a participatory approach where members of the public take an active role in the research process, provides an opportunity to better understand the sociocultural contexts, needs and personal expectations characteristic of each community (e.g. schools, patient groups etc). Having access to this information can help design more effective engagement and communication strategies which are appropriate for each community setting.

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YOUGOV 2017b. YouGov / Clientearth Survey Results. *Fieldwork: 2nd - 3rd February 2017.*

YOUGOV 2017c. YouGov / Purpose Survey Results. *Fieldwork: 12th - 13th December 2017.*

Appendix A. Ethical approvals

Appendix A1. Primary School (PS)

Diana Silva
Room 3.30
Franklin-Wilkins Building
150 Stamford Street
SE1 9NH

25 February 2015

Dear Diana Silva

BDM/14/15-39 Air Pollution Exposure and Behaviour Change Study

Review Outcome: Full Approval

Thank you for sending in the amendments/clarifications requested to the above project. I am pleased to inform you that these meet the requirements of the BDM RESC and therefore that full approval is now granted.

Please ensure that you follow all relevant guidance as laid out in the King's College London Guidelines on Good Practice in Academic Research (http://www.kcl.ac.uk/college/policyzone/index.php?id=247).

For your information ethical approval is granted until 25/02/2016. If you need approval beyond this point you will need to apply for an extension to approval at least two weeks prior to this explaining why the extension is needed, (please note however that a full re-application will not be necessary unless the protocol has changed). You should also note that if your approval is for one year, you will not be sent a reminder when it is due to lapse.

Ethical approval is required to cover the duration of the research study, up to the conclusion of the research. The conclusion of the research is defined as the final date or event detailed in the study description section of your approved application form (usually the end of data collection when all work with human participants will have been completed), not the completion of data analysis or publication of the results.

For projects that only involve the further analysis of pre-existing data, approval must cover any period during which the researcher will be accessing or evaluating individual sensitive and/or un-anonymised records.

Note that after the point at which ethical approval for your study is no longer required due to the study being complete (as per the above definitions), you will still need to ensure all research data/records management and storage procedures agreed to as part of your application are adhered to and carried out accordingly.

If you do not start the project within three months of this letter please contact the Research Ethics Office.

Should you wish to make a modification to the project or request an extension to approval you will need approval for this and should follow the guidance relating to modifying approved applications:

http://www.kcl.ac.uk/innovation/research/support/ethics/applications/modifications.aspx

Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

If you have any query about any aspect of this ethical approval, please contact your panel/committee administrator in the first instance (http://www.kcl.ac.uk/innovation/research/support/ethics/contact.aspx). We wish you every success with this work.

Yours sincerely,

Tom Billins, Senior Research Ethics Officer
For and on behalf of
Dr Blanaid Daly, Chair
Biomedical Sciences, Dentistry, Medicine and Natural and Mathematical Sciences Research Ethics Subcommittee (BDM RESC)

Cc. Benjamin Barratt

Appendix A2. Parent and baby group (P&BG)

Research Ethics Office

Franklin Wilkins Building
5.9 Waterloo Bridge Wing
Waterloo Road
London SE1 9NH
Telephone 020 7848 4020/4070/4077
rec@kcl.ac.uk

KING'S College LONDON

Mrs Diana Silva

Franklin-Wilkins Building Room 3.30, 150 Stamford Street, London
London
SE1 9NH

17 August 2015

Dear Diana

Reference Number: LRS-14/15-1280

Study Title: Air pollution and behaviour change

Review Outcome: Approval with Provisos

Thank you for submitting your application for the above project. I am pleased to inform you that your application has now be approved with the provisos indicated at the end of this letter. All changes must be made before data collection commences. The Committee does not need to see evidence of these changes, however supervisors are responsible for ensuring that students implement any requested changes before data collection commences.

Please ensure that you follow all relevant guidance as laid out in the King's College London Guidelines on Good Practice in Academic Research (http://www.kcl.ac.uk/college/policyzone/index.php?id=247).

For your information, ethical approval is granted until **17/08/2016**. If you need approval beyond this point, you will need to apply for an extension at least two weeks before this. You will be required to explain the reasons for the extension. However, you will not need to submit a full re-application unless the protocol has changed. If you have been granted approval for only 12 months, you will not be sent a reminder when it is due to lapse.

Ethical approval is required to cover the data-collection phase of the study. This will be until the date specified in this letter. However, you do not need ethical approval to cover subsequent data analysis or publication of the results.

For secondary data-analysis, ethical approval is applicable to the data that is sensitive or identifies participants. Approval is applicable to period in which such data is accessed or evaluated.

Please note you are required to adhere to all research data/records management and storage procedures agreed to as part of your application. This will be expected even after the completion of the study.

If you do not start the project within three months of this letter please contact the Research Ethics Office.

Please note that you will be required to obtain approval to modify the study. This also encompasses extensions to periods of approval. Please refer to the URL below for further guidance about the process:

http://www.kcl.ac.uk/innovation/research/support/ethics/applications/modifications.aspx

Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

If you have any query about any aspect of this ethical approval, please contact your panel/committee administrator in the first instance (http://www.kcl.ac.uk/innovation/research/support/ethics/contact.aspx)

We wish you every success with this work.

Yours sincerely,

Senior Research Ethics Officer

For and on behalf of

Chair

Biomedical Sciences, Dentistry, Medicine and Natural & Mathematical Sciences Research Ethics Subcommittee

Appendix A3. Senior citizen group (SCG)

Research Ethics
Office

Franklin Wilkins Building
5.9 Waterloo Bridge Wing
Waterloo Road
London SE1 9NH
Telephone 020 7848 4020/4070/4077
rec@kcl.ac.uk

KING'S College LONDON

Diana Silva Sarmiento

18 January 2016

Dear Diana,

Study Title: Air pollution and behaviour change - Senior Citizens

Study Reference: LRS-15/16-2313

I am pleased to inform you that full approval for your project has been granted by the BDM Research Ethics Subcommittee

Please ensure that you follow all relevant guidance as laid out in the King's College London Guidelines on Good Practice in Academic Research (http://www.kcl.ac.uk/college/policyzone/index.php?id=247).

For your information, ethical approval is granted until 18/01/2017. If you need approval beyond this point, you will need to apply for an extension at least two weeks before this. You will be required to explain the reasons for the extension. However, you will not need to submit a full re-application unless the protocol has changed. If you have been granted approval for only 12 months, you will not be sent a reminder when it is due to lapse.

Ethical approval is required to cover the data-collection phase of the study. This will be until the date specified in this letter. However, you do not need ethical approval to cover subsequent data analysis or publication of the results.

For secondary data-analysis, ethical approval is applicable to the data that is sensitive or identifies participants.

Approval is applicable to period in which such data is accessed or evaluated.

Please note you are required to adhere to all research data/records management and storage procedures agreed to as part of your application. This will be expected even after the completion of the study.

If you do not start the project within three months of this letter, please contact the Research Ethics Office.

Please note that you will be required to obtain approval to modify the study. This also encompasses extensions to periods of approval. Please refer to the URL below for further guidance about the process:

http://www.kcl.ac.uk/innovation/research/support/ethics/applications/modifications.aspx

Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

If you have any query about any aspect of this ethical approval, please contact the Research Ethics Office:

(http://www.kcl.ac.uk/innovation/research/support/ethics/contact.aspx)

We wish you every success with this work.

Yours sincerely,

Tom Billins

Senior Research Ethics Officer

For and on behalf of

Blanaid Daly

Chair of the BDM Research Ethics Subcommittee

Page 1 of 1

Appendix A4. Cardio Obstructive Pulmonary Disease Group (COPDG)

NHS
Health Research Authority
London - Brent Research Ethics Committee
80 London Road
Skipton House
London
SE1 6LH

Telephone: 020 7972 2554

28 September 2015

Dr Benjamin Barratt
Lecturer in Air Quality Science
King's College London
Franklin Wilkins Building
Room 3.30
150 Stamford Street, London
SE1 9NH

Dear Dr Barratt

Study title: **Assessing the impact of air pollution information and evidence gathered through community-led projects on individuals' perceptions and behaviour.**
REC reference: **15/LO/1691**
Protocol number: **n/a**
IRAS project ID: **183589**

Thank you for your letter of 26th September 2015. I can confirm the REC has received the documents listed below and that these comply with the approval conditions detailed in our letter dated 25 September 2015

Documents received

The documents received were as follows:

Document	*Version*	*Date*
Participant consent form [Consent Form]	2	26 September 2015

Approved documents

The final list of approved documentation for the study is therefore as follows:

Document	*Version*	*Date*
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [KCL insurance indemnity]	1	15 July 2015
Interview schedules or topic guides for participants [Interview	1	15 August 2015

Indicative Questions]		
IRAS Checklist XML [Checklist_14092015]		14 September 2015
Participant consent form [Consent Form]	2	26 September 2015
Participant information sheet (PIS) [Information Sheet Group I]	1	15 August 2015
Participant information sheet (PIS) [Information Sheet Group II]	1	15 August 2015
REC Application Form [REC_Form_14092015]		14 September 2015
Research protocol or project proposal [Protocol]	1	15 August 2015
Summary CV for Chief Investigator (CI) [Ben Barratt CV]	1	15 August 2015
Summary CV for student [Diana Silva CV]	1	15 August 2015
Summary CV for supervisor (student research) [Ben Barratt CV]	1	15 August 2015
Summary, synopsis or diagram (flowchart) of protocol in non technical language [Project Stages Diagram Group I]	1	15 August 2015
Summary, synopsis or diagram (flowchart) of protocol in non technical language [Project Stages Diagram Group II]	1	15 August 2015
Validated questionnaire [1st survey]	1	15 August 2015
Validated questionnaire [2nd Survey]	1	15 August 2015

You should ensure that the sponsor has a copy of the final documentation for the study. It is the sponsor's responsibility to ensure that the documentation is made available to R&D offices at all participating sites.

15/LO/1691 **Please quote this number on all correspondence**

Yours sincerely

Julie Kidd
REC Manager

E-mail: nrescommittee.london-brent@nhs.net

Copy to: *Mr Keith Brennan*
Mrs Sheena Radford, Barts Health Trust

Joint Research Management Office
Queen Mary Innovation Centre
5 Walden Street
London
E1 2EF

Tel: 020 7882 7260
Fax: 020 7882 7276
Email: Sponsorsrep@bartshealth.nhs.uk

FINAL R&D APPROVAL

26th January 2016

Mr Martin Sterry
Barts Health NHS Trust
The Royal London Hospital
London
E1 1BB

Dear Martin,

Protocol: **Assessing the impact of air pollution information and evidence gathered through community-led projects on individuals' perceptions and behaviour.**

ReDA Ref: **010944**
REC Ref: **15/LO/1691**

I am pleased to inform you that the Joint Research Management Office for Barts Health NHS Trust and Queen Mary University of London has approved the above referenced study and in so doing has ensured that there is appropriate indemnity cover against any negligence that may occur during the course of your project. Approved study documents are as follows:

Type	Version	Date
Protocol	1	15.08.2015
Group I Information Sheet	1	15.08.2015
Group II Information Sheet	1	15.08.2015
Consent Form	2	26.09.2015

Please note that all research within the NHS is subject to the Research Governance Framework for Health and Social Care, 2005. If you are unfamiliar with the standards contained in this document, or the BH and QMUL policies that reinforce them, you can obtain details from the Joint Research Management Office or go to:
http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4108962

You must stay in touch with the Joint Research Management Office during the course of the research project, in particular:

- If there is a change of Principal Investigator
- When the project finishes
- If amendments are made, whether substantial or non-substantial

This is necessary to ensure that your R&D Approval and indemnity cover remain valid. Should any Serious Adverse Events (SAEs) or untoward events occur it is **essential** that you inform the Sponsor within 24 hours. If patients or staff are involved in an incident, you should also follow the Trust Adverse Incident reporting procedure or contact the Risk Management Unit on 020 7480 4718.

We wish you all the best with your research, and if you need any help or assistance during its course, please do not hesitate to contact the Office.

Yours sincerely

Gerry Leonard, Head of Research Resources

Copy to: Sponsor Organisation

Appendix A5. Breathe London Projects

Research Ethics
Office

Franklin Wilkins Building
5.9 Waterloo Bridge Wing
Waterloo Road
London SE1 9NH
Telephone 020 7848 4020/4070/4077
reo@kcl.ac.uk

KING'S College LONDON

Mrs Diana Silva Sarmiento

10 June 2016

Dear Diana

LRS-15/16-3268 - Air pollution and behaviour change - Breathelondon Projects

I am pleased to inform you that full approval for your project has been granted by the BDM Research Ethics Panel

- Ethical approval is granted for a period of **one year** from 10 June 2016 . You will not receive a reminder that your approval is about to lapse. It is your responsibility to apply for an extension prior to the project lapsing.
- You should report any untoward events or unforeseen ethical problems to the panel Chair, via the Research Ethics Office, within a week of occurrence. Information about the panel may be accessed at: http://www.kcl.ac.uk/innovation/research/support/ethics/committees/sshl/reps/index.aspx
- If you wish to change your project or request an extension of approval, please complete and submit a Modification Request to crec-lowrisk@kcl.ac.uk. Please quote your ethics reference number, found at the top of this letter, in all correspondence with the Research Ethics Office. Details of how to complete a modification request can be found at: http://www.kcl.ac.uk/innovation/research/support/ethics/applications/modifications.aspx
- All research should be conducted in accordance with the King's College London *Guidelines on Good Practice in Academic Research* available at: http://www.kcl.ac.uk/college/policyzone/assets/files/research/good%20practice%20Sept%2009%20FINAL.pdf

Please note that we may, for auditing purposes, contact you to ascertain the status of your research.

We wish you every success with your research.

Best wishes,

BDM Research Ethics Panel REP Reviewers

Appendix B. Senior citizen newsletter

Modern World Reports Feb 9 – Mar 22

9 February Air Pollution: London's Invisible Killer

Diana Silva, a second year PhD student from King's College London, gave us a passionate and enthusiastic account of her work in measuring directly the degree of air pollution that we encounter in our daily lives as residents of London. Diana's work is focused specifically on the Greater London area and is intended to be used to inform the decisions of policy makers in this field. More specifically, Diana's study draws on observation, surveys and interviews, to examine the impact that access to personalised air pollution data has on the behaviour of individuals in the short and medium term. Diana is keen to engage with the community, and has worked with local communities and schools to get their active participation; this has now been extended to our own group, with 12 Bromley U3A volunteers agreeing to wear air monitoring devices for 24 hours, supported by GPS tracking, so that the research team may correlate pollution levels with location throughout the monitoring period. Diana is working specifically on road traffic pollution, and the impact of the growing use of diesel engines, once thought to be better for the environment, and now seen as a potentially serious threat to our health. We were reminded of the great smog of 1952 and the positive impact that the subsequent legislation has had on our clear air. Perhaps of more concern is that Bromley has reduced its own monitoring stations as part of its Air Quality Action Plan from 5 to just 1, which is located in Harwood Avenue apparently - hardly exposed to the thrust of Bromley road traffic (Although not mentioned at the meeting, I discovered afterwards that Bromley's Air Quality Action Plan is available to view on the Borough's web site and is an interesting read,

Continued next page

Modern World Reports continued

although a little dated now as it hails from 2010). The chemical pollutants of concern include Nitrogen Dioxide, for which London has a target of no more than 18 measures to exceed the recommended safe level through all of 2016 in the whole of London; as of 5th February 2016, the London Borough of Putney has already had in excess of 100 measures that exceeded this limit. We have a long way to go, but Diana was reassuring that London at least is trying to measure the problem, whereas many other cities in Europe are not, and so the degree of risk there remains unknown.

Appendix C. Example of a completed diary

Activity Diary

Participant ID : F

Date	Start Time	End Time	Activity	Comments
11.2.16	12.05	12.20	Walk to car park, drive home along main road	Small petrol car, not recycling air internally
	12.20	12.30	Make toast in toaster!	
	12.30	12.45	Drive, park car, walk along busy street, to hairdresser's.	
	13.20	13.30	Walk to car park, drive home mostly on busy roads	
	18.55	19.25	Drive on main roads then country lanes	Larger diesel car not recyling air internally
12.2.16	11.30	15.00	Drive in big car to Chartwell on fairly busy roads. Visit studio, back to cafe, back to house, back to car and home. On the way home pass Biggin Hill airport - 4 engine plane just landed and helicopter overhead	— " —
	15.00	15.30	AE home	
13.2.16	9.20	13.05	Walk to station (almost no traffic), train to Cannon St, walk to Tower Hill, coffee stop, Four church, walk to Cannon St, train, walk back, few minutes at home	Heavy, crawling traffic London Bridge to Tower Hill (both ways)
14.2.16	10.10	12.10	Walk via quiet streets through park, more quiet streets, coffee stop and back on same route. Few minutes at home.	

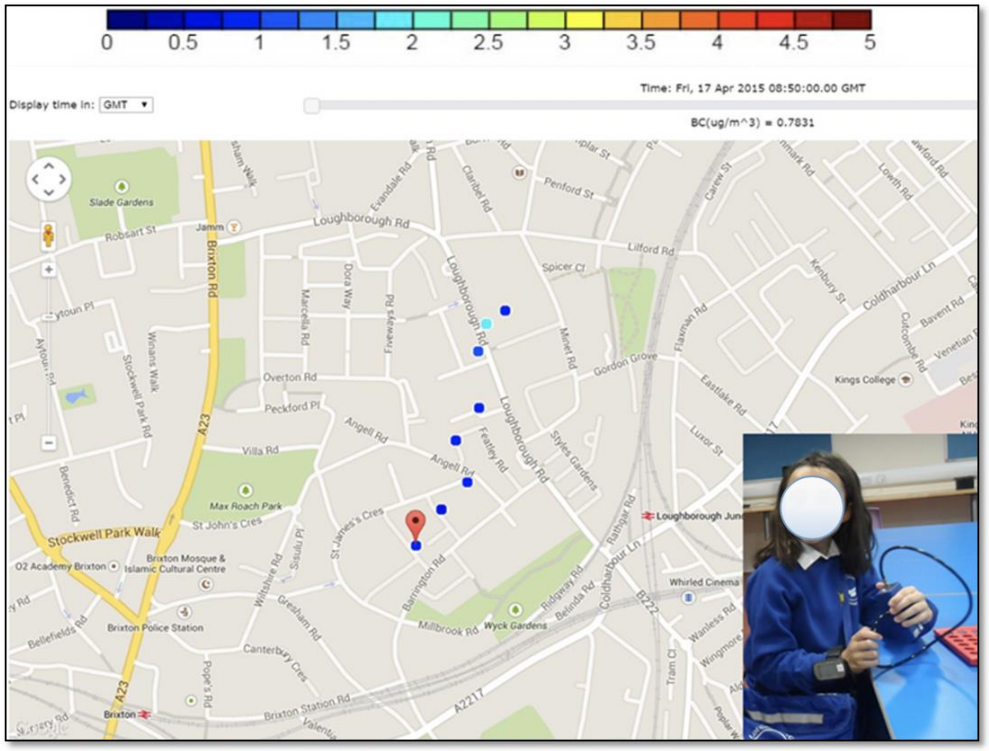
Appendix D1. Example of report given to children at primary school.

Primary School Air Pollution Project Results

Accompanied by their parents/carers, ten children from XXX Primary school measured the air pollution they were exposed to as they travelled to and from school using portable exposure monitors and GPS watches. The measurements took place between 14th and 20th of April 2015 and here are the results!

Air Quality Scientist: Lucy Ribeiro (4A)

Measuring day: 17th of April 2015



Lucy's data shows low levels of air pollution (Black Carbon) on most of her route apart from some higher levels recorded on Loughborough Road. Most of the black carbon in London comes from diesel vehicle exhaust.

Why is Pollution bad for children?

Children are particularly vulnerable to air pollution as their lungs are still developing. Harm done at this stage of development may stay with them throughout their adult life. As with the daily commute, travel to and from school usually occurs during the most polluted times of the day and can account for a large proportion of a child's daily exposure.

What can we do to reduce children's exposure to air pollution?

- ✓ Studies in London have shown that walking to school will expose you/your child to lower levels of pollution than travelling in a car or bus - cars do not provide protection from traffic fumes.
- ✓ Choose a low pollution walking or cycling route to school by avoiding busy roads or using our route planner.
- ✓ Walking or cycling to school will not only expose you/your child to less pollution, it will provide all of the benefits of exercise and expose classmates to less pollution by improving air quality around the school.
- ✓ If the school is close to a major road, ask what steps have been taken to protect the children from air pollution in the school buildings and playground.
- ✓ Ask to see the school's travel plan and check that is has consideration for active travel and local air quality.
- ✓ If you have to drive, close windows and vents when driving along busy roads or sitting in queuing traffic.

Visit our website http://breathelondon.org/ to find more tips, the air pollution forecasts and our awesome tool to plan a lower pollution travel route.

If you have any questions regarding the air pollution project at Loughborough Primary School or want to find our more please contact me at diana.silva.s@kcl.ac.uk

Appendix D2. Example of feedback report

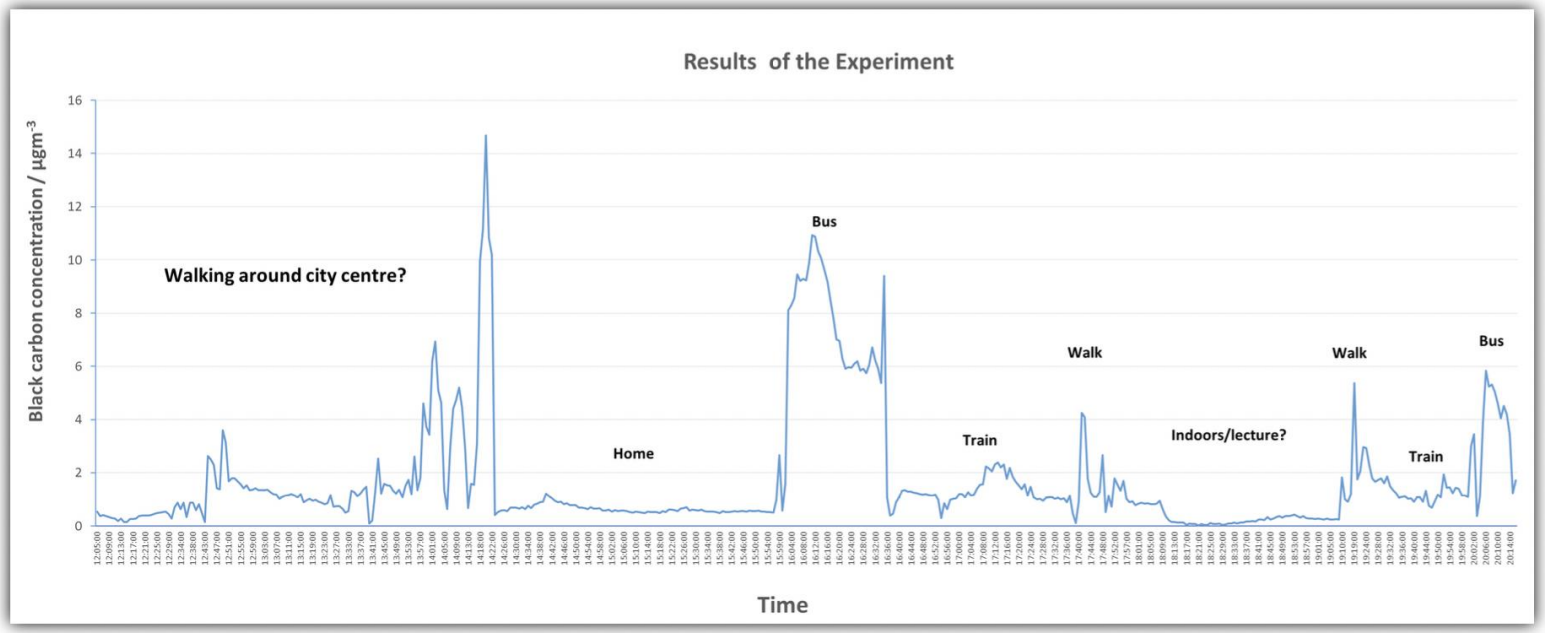
Air Pollution Project Results

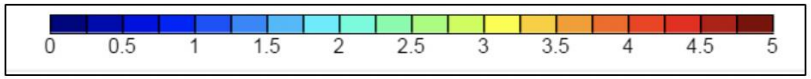
Modern World group

Bromley U3A

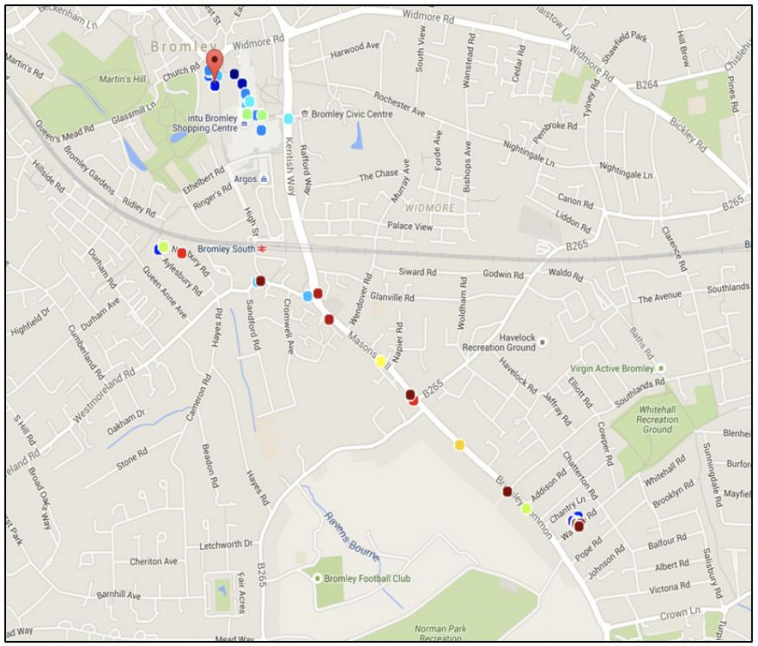
Participant A

9th of February 2016

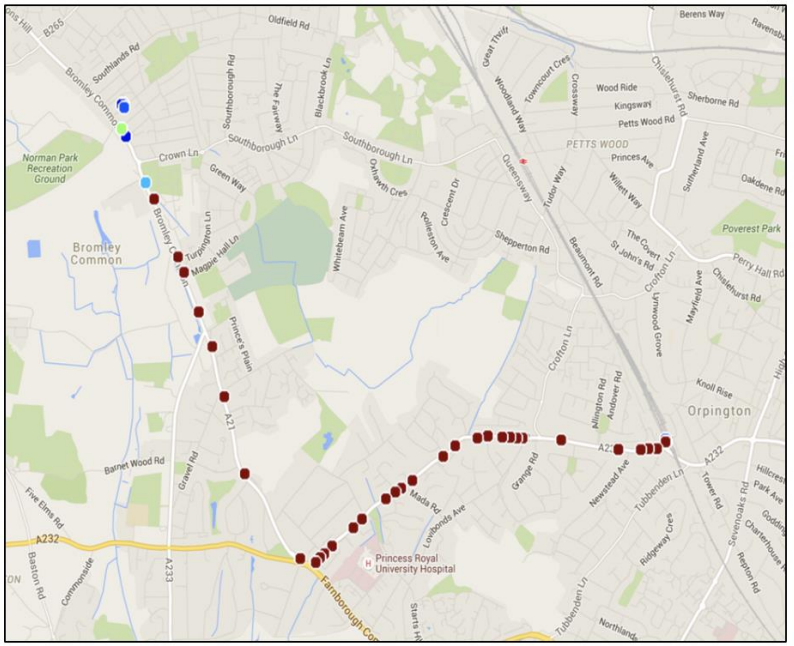




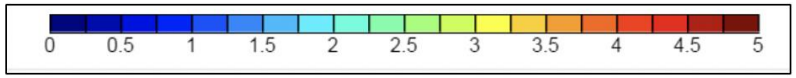
Time: 13:33am – 15:29pm



Time: 15:46pm – 16:36pm

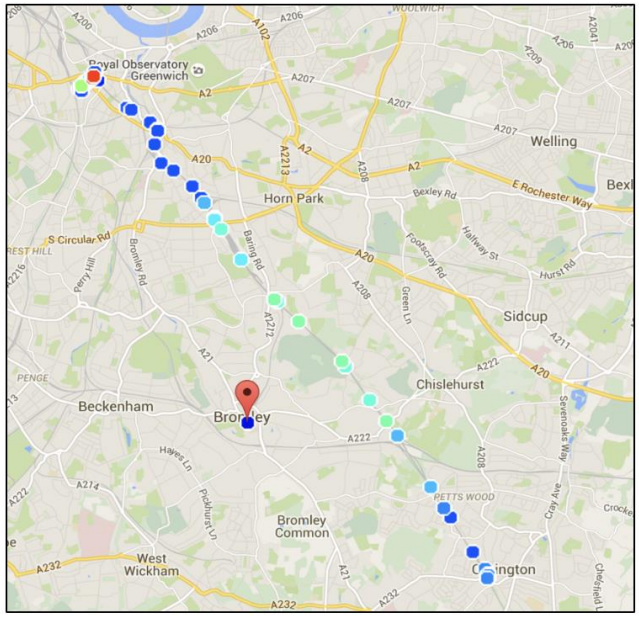


Real Time GeOspatial viewer (RETIGO)
U.S. Environmental Protection Agency



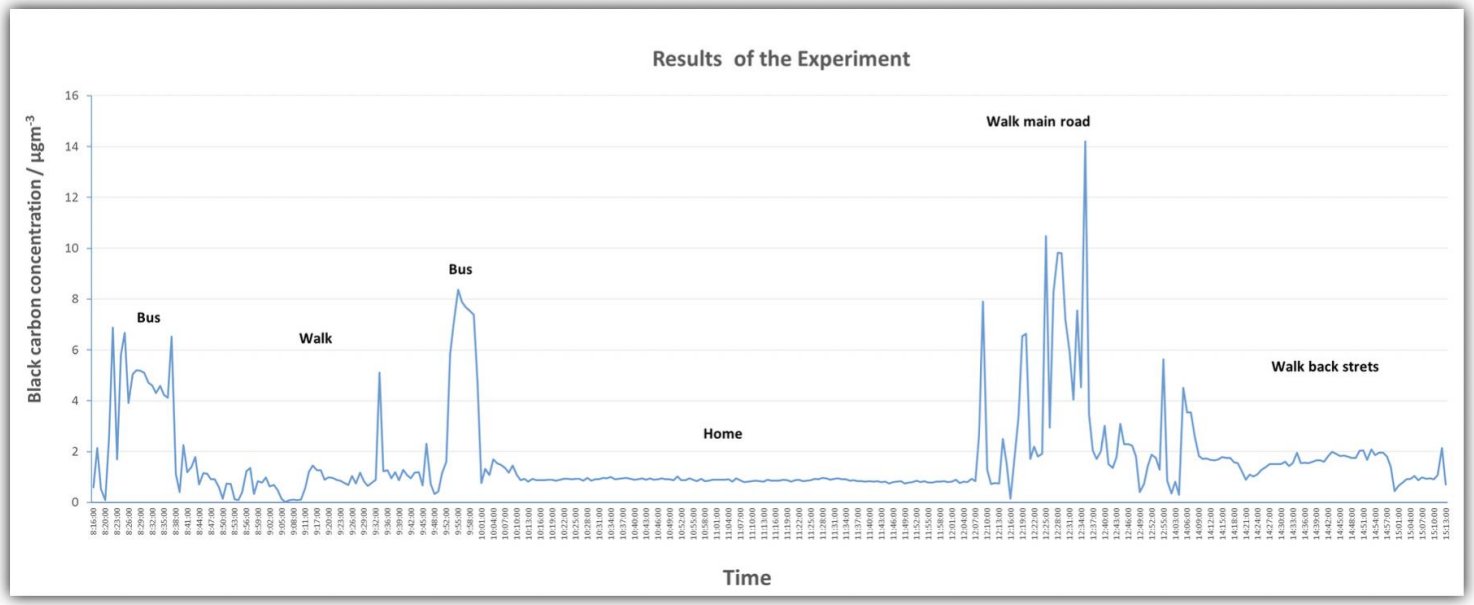
BC(ug/m^3)

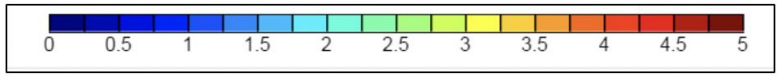
Time: 16:52pm-17:50pm



Real Time GeOspatial viewer (RETIGO)
U.S. Environmental Protection Agency

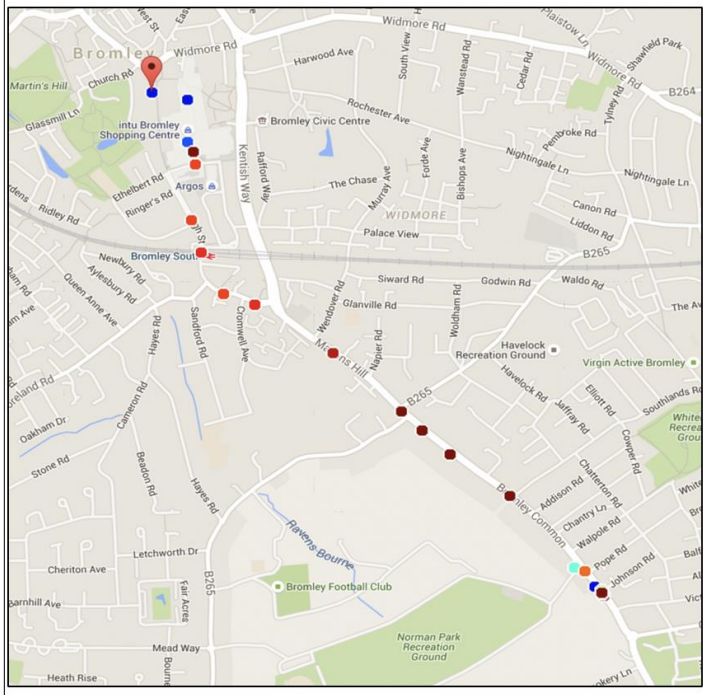
10th of February 2016



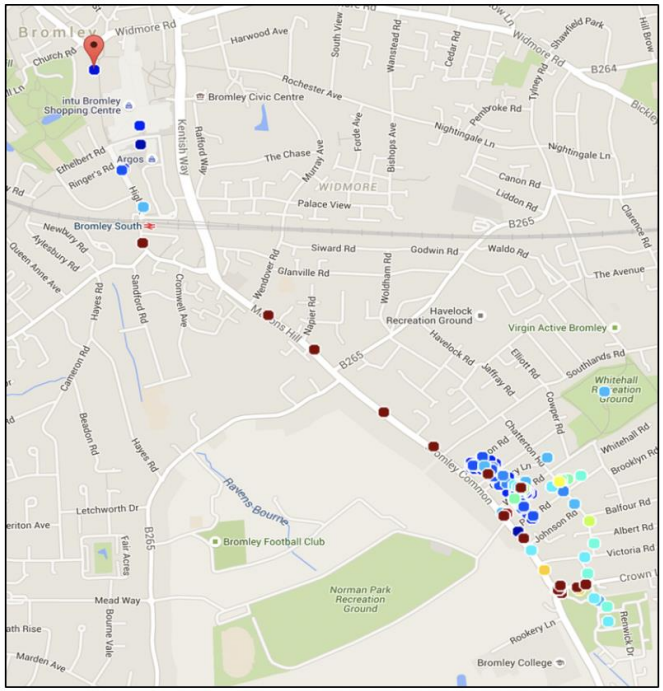


BC(ug/m^3)

Time: 8:18 am -8:39am



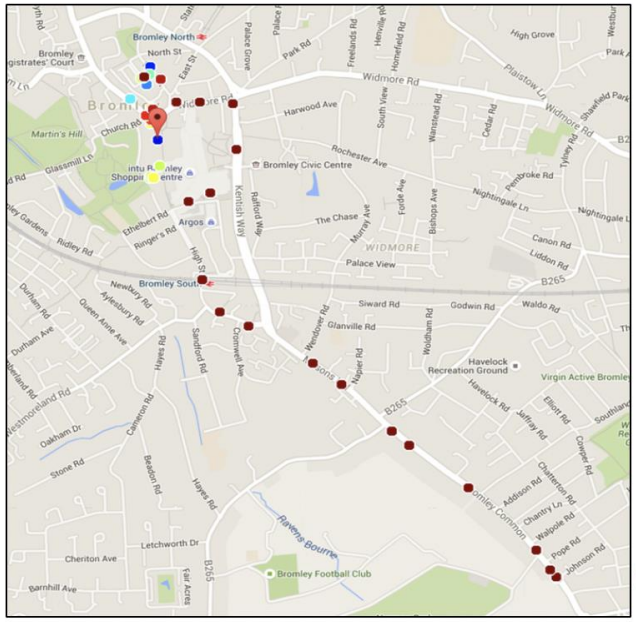
Time: 9:47am- 12:55pm



11th of February 2016

BC(ug/m^3)

Time: 10:40am-11:24am (Bus Journey)



Real Time GeOspatial viewer (RETIGO)
U.S. Environmental Protection Agency

Individual Exposure Results

Activity	Mean Exposure
Walking around city centre	1.8
Home	0.8
Bus	6.1
Train	1.4
Walk	1.8

Group Exposure Results

	Mean Exposure							
Participant	Home	Garden	Shopping	Indoors	Walk	Bus	Train	Driving
A	0.8				1.8	6.1	1.4	
B	1.1	0.9			3.0			
C	0.5			1.1	3.3			
D	3.1	3.2	0.8		2.5	5.6		
E	8.4			2.0	4.1	14.4		1.9
F	0.7			1.9	1.8		1.2	1.9
G	1.0		2.5		1.6	4.2		
H					2.4	4.5	3.7	3.2
I		1.1			2.1	7.7	2.9	4.2
J	1.1		1.0	0.7	1.8	12.4		
K	1.5		2.1	1.0		4.0		2.2

On my commute and at work

A healthier journey to work

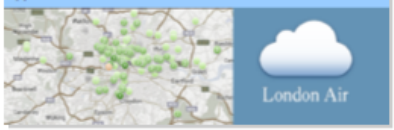
1. Cycling or walking benefits your health and helps to improve air quality in London. Try to incorporate active travel into at part or all of your commute.

3. If you have to drive, close windows and vents when driving along busy roads or sitting in queuing traffic.

4. If you work in an office or building close to a major road, ask the building supervisors what actions have been taken to minimise the infiltration of pollution into the building. Buildings with mechanical ventilation should be fitted with effective inlet filers.

5. One of our community monitoring projects found that pollution levels within shops that operated an open door policy were higher than those had closed doors

Visit **www.londonair.org.uk** for real time air quality maps, apps stats and news.



In my neighborhood

Tips for helping those who live around you

1. Be aware of where pollution levels are highest in your local area. You can enter your postcode into our pollution mapping tool to see annual mean concentrations.

2. If you belong to a community group, use the information on our website, and other sites providing air pollution information, to inform and empower your neighbourhood and improve its health. Read the projects on our website to see what others have done, or enquire about Clean Air Champions in your borough.

3. Propose a project. While we can't support individuals, we want to hear from community groups who have ideas for projects to increase awareness and reduce air pollution exposure in their neighbourhood.

Visit our website **www.breathelondon.org** to find more tips, the air pollution forecast, the route planner and much more !

How to breathe cleaner air...

Biomedical Research Centre at Guy's and St Thomas NHS Foundation Trust and King's College London

At home

Tips to reduce your exposure at home

1. The greatest risk of harm from air pollution in the home is from poorly maintained gas fires or heaters. Make sure these appliances are serviced regularly and consider installing a carbon monoxide alarm.

2. If you have an extraction fan installed, use it! This is particularly important when cooking with gas.

3. Insulating your home will not only prevent heat escaping, reducing heating bills, but also help to reduce the amount of outdoor air pollution entering.

4. If you live close to a busy road, give preference to opening windows on the side of the home furthest from the road.

5. Don't smoke or allow others to smoke in your home (or car). Tobacco smoke can easily travel between rooms and closing an internal door is not adequate protection.

On my walk/run

Tips to make your urban walk or run healthier

1. Pollution levels close to busy roads can be many times higher than in parks and quieter streets. Pick a running/walking route that avoids traffic. It will be safer, quieter, more pleasant and better for your health. You could use our route planner to try out new routes.

2. Pollution levels vary greatly by time of day and day of the week. Try and time your run to avoid the morning rush hour. The lowest levels during the day are usually around lunch time. Air quality is often significantly better on Sundays.

3. Some people with asthma and other respiratory conditions may find that they are affected by ozone pollution or 'summertime smog'. If you find exercise more difficult on sunny days, avoid the afternoon and early evening, when ozone levels are highest.

4. You may wish to limit your exercise on particularly polluted days. Use the pollution forecast in much the same way you would a weather forecast, avoiding the worst of the weather and pollution.

At school

Tips to reduce children's exposure

1. Studies in London have shown that walking to school will expose you/your child to lower levels of pollution than travelling in a car or bus - cars do not provide protection from traffic fumes.

2. Choose a low pollution walking or cycling route to school by avoiding busy roads or using our route planner.

3. Walking or cycling to school will not only expose you/your child to less pollution, it will provide all of the benefits of exercise and expose your/their classmates to less pollution by improving air quality around the school.

4. If the school is close to a major road, ask what steps have been taken to protect the children from air pollution in the school buildings and playground.

5. Ask to see the school's travel plan and check that is has consideration for active travel and local air quality.

Appendix F. Questionnaires

Appendix F1. Primary school surveys

Pre-survey

Children:

1) Did you have fun learning about air pollution?

   - ☐ Yes
   - ☐ No

2) Thinking about the results presented today... Is your route to and from school affected by air pollution?

   - ☐ Yes
   - ☐ No
   - ☐ I don't remember

3) Would you tell your parents/carers what you learned today about air pollution?

   - ☐ Yes
   - ☐ No
   - ☐ I don't know

Parents/carers:

1. Were you surprised by the results found from the air quality study carried out at xxx School?

   - ☐ Yes
   - ☐ No

2. Thinking about the results … Is your route to and from school affected by air pollution?

   - ☐ Yes
   - ☐ No
   - ☐ I don't 'know

   (If you answer is yes, please go to question 3, otherwise go to question 4).

3. How likely are you to change the route you take to and from school in order to avoid air pollution?

   - ☐ Not very likely
   - ☐ Likely
   - ☐ Very likely

4. How likely are you to tell your family and friends about the findings of this study?

   - ☐ Not very likely
   - ☐ Likely
   - ☐ Very likely

Post-survey (after 3 months of receiving the results)

Air pollution Project

[redacted] Primary School

KING'S College LONDON

After the air pollution project at school…

1) **Did you speak to your parents about air pollution?**

☐ Yes
Why? ……

☐ No
Why? ……

2) **Did you do any of the following?** **(You can select more than one)**

☐ I walked or cycled more instead of using the car.

☐ I chose low pollution routes to walk or cycle to school by avoiding busy roads.

☐ I didn't do any of the above.
why?……

Air pollution Project

[redacted] Primary School

Dear Parent/Carer,
Could you please take time to fill in this questionnaire and return it to the school office.

After the air pollution project at school…

1. **Did you speak to any friends or family about the air pollution project we did at school?**

☐ Yes
Why? ……

☐ No
Why? ……

2. **Did you do any of the following? (You can select more than one)**

☐ I walked or cycled more instead of using the car.
☐ I chose low pollution routes when walking or cycling by avoiding busy roads.
☐ I closed the car windows and vents when travelling by car along busy roads or sitting in queuing traffic.
☐ I didn't do any of the above.
Why?……

3. **How did this project improve your awareness of air pollution?**

☐ A Lot
☐ A little
☐ Not at all

4. **Do you have any other comments, or feedback?**

……

Thank you.

Appendix F2. Surveys conducted with Senior citizens group (SCG), Parent and baby group (P&BG) and Cardio Obstructive Pulmonary Disease Group(COPDG)

Pre- Surveys

Air Pollution Project

KING'S College LONDON

Could you please take the time to fill in this questionnaire and return it to the researcher before you leave today.

1. **What is your ethnic group? Please choose the option that best describes your ethnic group or background**

   - ☐ White, or
   - ☐ Mixed/ Multiple ethnic groups, or
   - ☐ Asian/ Asian British, or
   - ☐ Black/ African/ Caribbean/ Black British, or
   - ☐ Chinese, or
   - ☐ Arab, or
   - ☐ Other ethnic group
   - ☐ Prefer not to say

2. **Which range includes your age?**
   - ☐ Younger than 18
   - ☐ 18 - 24
   - ☐ 25 - 34
   - ☐ 35 - 44
   - ☐ 45 - 54
   - ☐ 55 - 64
   - ☐ 65 or older
   - ☐ Prefer not to answer

3. **Are you?**
   - ☐ Female
   - ☐ Male
   - ☐ Prefer not to answer

4. **How much do you know about air pollution?**
   Please mark the scale

   Nothing 1 2 3 4 5 *a lot*

5. **How concerned are you about air pollution?**
   Please mark the scale

   Not concerned at all 1 2 3 4 5 *extremely concerned*

6. **Do you think air pollution affects people's health?**

   ☐ Yes
   ☐ No
   If yes, in what ways?
   ……
   ……

7. **How important do you think improvement in air quality is for public health reason?**

   Not important at all 1 2 3 4 5 *very important*

8. **Do you think it is possible to reduce the amount of air pollution you are exposed to by changing your behaviour?**

   ☐ Yes
   ☐ No
   If yes, could you give some examples:
   ……
   ……

Thank you

Post-Surveys

Air Pollution Project

KING'S College LONDON

Dear Parent/Carer, could you please take the time to fill in this questionnaire and return it to the researcher before you leave today.

1. What is your ethnic group? Please choose the option that best describes your ethnic group or background

- ☐ White, or
- ☐ Mixed/ Multiple ethnic groups, or
- ☐ Asian/ Asian British, or
- ☐ Black/ African/ Caribbean/ Black British, or
- ☐ Chinese, or
- ☐ Arab, or
- ☐ Other ethnic group
- ☐ Prefer not to say

2. Which range includes your age?

- ☐ Younger than 18
- ☐ 18 - 24
- ☐ 25 - 34
- ☐ 35 - 44
- ☐ 45 - 54
- ☐ 55 - 64
- ☐ 65 or older
- ☐ Prefer not to answer

3. Are you?

- ☐ Female
- ☐ Male
- ☐ Prefer not to answer

4. How much do you know about air pollution?
Please mark the scale

Nothing 1 2 3 4 5 a lot

5. How concerned are you about air pollution?
Please mark the scale

Not concerned at all 1 2 3 4 5 extremely concerned

Please turn this page over and continue with questions on the reverse, Page 2.

6. Do you think air pollution affects people's health?

- ☐ Yes
- ☐ No

If yes, in what ways?

.....

.....

.....

7. How important do you think improvement in air quality is for public health reason?

Please mark the scale

Not important at all *1* *2* *3* *4* *5* *very important*

8. Do you think it is possible to reduce the amount of air pollution you are exposed to by changing your behaviour?

- ☐ Yes
- ☐ No

If yes, could you give some examples:

.....

.....

.....

9. Did you speak to any friends or family about the air pollution project at the Riverside Parents Group?

- ☐ Yes

  Why? .....
- ☐ No

  Why? .....

10. Do you have any other comments, or feedback?

.....

.....

Thank you

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Appendix G. Interview topic guide

Appendix G1. Interviews topic guide for primary school

Children

Reasons for taking part in this study.

1. Why did you/your parent decide to participate in this project?

Initial thoughts participants have after receiving the data.

2. What do you think about the data you collected? Were you surprised with the results? Did the results show air pollution on your route? What was the most significant finding for you ?

3. Were you expecting these results yes/no why?

4. What do you think was the most important thing you learnt from the air pollution project? if anything.

Impact that access to this personal exposure data had in the participants live styles.

5. After seeing the results of the project and receiving advice as to how reduce your air pollution exposure… did you/your parent/carer change any lifestyle (behaviour) in order to avoid/reduce the air pollution you were being exposed to? Why yes- why not? What did you do?

6. Why do you think your behaviour did/didn't change? What were the motivations/constraints?

7. Have you noticed/perceive any improvement in your health/wellbeing after changing/adopting behaviour?

Dissemination of project findings with family, friends and community

8. Did you speak to any members of your family/friends about this? Do you think that you managed to influence the way they think about air pollution ?

Parent and carer

Reasons for taking part in this study:

1. Why did you/your child decide to participate in this project?

Initial thoughts participants have after receiving the data.

2. What do you think about the data the children/you collected? Were you surprised with the results? Did the data collected by the children show air pollution on your child's route? What was the most significant finding?

3. Were you expecting these results yes/no why?

4. What do you think was the most important thing you learnt from the air pollution project?

Impact that access to this personal exposure data had in the participant's lifestyles.

5. After seeing the results of the project and receiving advice as to how reduce your air pollution exposure… did you change any lifestyle (behaviour) in order to avoid/reduce the air pollution you were being exposed to? Why yes- why not? What did you do?

6. Why do you think your behaviour did/didn't change? What were the motivations/constraints?

7. Have you noticed any improvement in your health/wellbeing after changing/adopting behaviour?

Dissemination of project findings with family, friends and community

8. Did you speak to any members of your family/community about this? Do you think that you managed to influence the way they think about air pollution?

School Deputy

About school

What do you think about the way the project was conducted? What could we do different next time?

Do you think the results were presented in an appropriate way? Could they generate fear/distress in children/parents?

Do you think that the advice given to the children regarding ways of minimising air pollution was clear?
Regarding the ice cream van? What do you think about this finding? Is the school planning to do something about it?

How do you think the children benefitted from this project?

At personal level

What do you think was the most important thing you learnt from the air pollution project?

After seeing the results of the project, do you think you will change any lifestyle (behaviour) in order to avoid/reduce the air pollution you were being exposed to?

Would you speak to any members of your family/community about this? Do you think that you will manage to influence the way they think about air pollution?

Appendix G2. Interview topic guide for senior citizens group (SCG), Parent and baby group (P&BG) and Cardio Obstructive Pulmonary Disease Group (COPDG)

Indicative Questions

1. What do you think about the air quality data you collected? Were you surprised with the results?

2. What do you think was the most important thing you learnt from the air pollution project?

3. After seeing the results of the project, did you change any lifestyle (behaviour) in order to reduce the air pollution you were being exposed to? Why yes- why not?

4. Why do you think your behaviour didn't change? What were the constraints?

5. Did you speak to any members of your family/community about this? Do you think that you managed to influence the way they think about air pollution?

6. Have you noticed any improvement in your health/wellbeing after changing behaviour?

Appendix G3. Interview topic guide for Breathe London Project (BLP) participants

1. How did you get involved in the project?
2. Why did you get involved in the project?
3. How did you find the logistics of taking the measurements? Carrying the device, turning on/off, filling in the diary? Did you find it difficult/easy?
4. What do you think about the air quality data you collected? Did you expect these sort of findings?
5. What do you think was the most important thing you learnt from the air pollution project?
6. Did you change anything in your daily routine in order to reduce the air pollution you were being exposed to? Why? Could you give some examples? (If no go to question 11)
7. Have you noticed any improvement in your health/wellbeing after doing this ?
8. Do you think that your views towards air quality issues changed after taking part in the project? And if so, how did they change?
9. How important do you think improvement in air quality is for public health reasons?
10. Did you speak to any members of your family/community about the air pollution project?
11. Do you think that you managed to influence their behaviour?
12. What did they say?
13. What else did you do with the air pollution data/evidence gathered?

Appendix H. Senior citizen newsletter

Update on our Air Pollution Monitoring Project

The 12 April this year saw the return of Diana Silva, the researcher who is conducting the air pollution project in London. She spoke briefly to Modern World. Twelve Bromley U3A members volunteered to assist in the survey in Bromley and preliminary results were available. Carbon detectors where carried for a period of 24 hours, carbon being treated as a proxy for nitrogen dioxide. We hope to have a full report on our part of the project to publish in a later edition of U3A Bromley News. However, early results show a marked difference in pollution levels between main roads, and backstreets which show considerably lower levels of pollution. While this was not unexpected, we also found bus travel generally gave high readings whereas train travel did not. This is a new finding and will require more research; meanwhile having at least one open window on the bus should help to expel contaminated air. High readings were also found in some homes during cooking, whereas watching TV produced very low readings. Preliminary advice is as follows: avoid the rush hour either am or pm, where you can. The lowest levels during the day are usually around lunch time. Don't take your early morning constitutional along the main roads, use back streets and/or parks. Take your exercise, e.g. walking the dog, in the late mornings/lunchtime as contamination tends to increase in the late afternoon, but pollution levels vary greatly by time of day and day of the week. Switch on the extractor hood over your stove when doing any cooking. If no extractor, then opening a window should help.

As so often happens in research projects, preliminary findings reveal the need to conduct more research in unanticipated areas.

Report by Martin Walter

Appendix I. Example of dissemination material